SCIENCE ABSTRACTS.

Section A.—PHYSICS.

JANUARY 1903.

GENERAL PHYSICS.

1. *Gauge for Small Pressures.* **E. W. Morley** and **C. F. Brush.** (Amer. Journ. Sci. 13. pp. 455–458, June, 1902.)—The authors describe two new forms of small-pressure gauge, one costly but rapid in action, the other simpler and suitable where few measurements are required and speed is not essential. The hydrostatic part consists of a small **V**-tube containing mercury, and this is carried by a beam resting at one end on two points, and at the other carried by a micrometer screw. The essence of the method is to tilt the beam by the screw until the two mercury surfaces come to the fiducial points in the **U**-tubes. The motion of the micrometer and the length of the beam then give the difference of level, and so the pressure difference. Small pressures may thus be read with an error of less than the ten-thousandth of a millimetre.

J. W. P.

2. *Spontaneous Decrease of the Surface-Tension of Water, Aqueous Solutions and Emulsions.* **A. Pockels.** (Ann. d. Physik, 8. 4. pp. 854–871, July, 1902.)—It is shown that the decrease in surface-tension observable in a water surface is due not only to impurities derived from the walls (glass) of the containing vessel, but also to dust particles from the air. Thus a sample of water protected from both sources of contamination showed no sign of impurity on its surface after twelve days, even when subjected to a severe test, *i.e.*, observation of the variation of its surface-tension on diminution of the surface by means of a movable partition. A gradual decrease of the surface-tension of "water" may be due, however, not only to the above-mentioned sources, but also to *inner*, *i.e.*, either dissolved or suspended impurities. This effect is very evident in the case of river water, or water which has been purposely contaminated with decaying vegetable matter. The decrease of surface-tension with time is greatly accelerated in the case of *salt-solutions* (as shown by Quincke). The authoress proves, however, that this effect is not due to the salts, but to something added with them, for (*a*) the effect gradually falls off to zero, as the surface of the solution is repeatedly brought to its initial condition by the dipping in and removal of strips of paper; (*b*) the effect disappears when the salt-solutions are filtered through a filter of wood-charcoal. These observations lead up to a very interesting series of experiments, in which the authoress shows that solutions of certain "active" substances, such as colophonium resin, mastix, shellack, palmitic and stearic acids, tannin, gelatine, egg-albumen and soap, show a rapid decrease in the surface-tension of fresh surfaces (as shown by Lord Rayleigh in the case of soap-solutions). This rapid decrease of surface-tension is shown also in a

very marked manner by *emulsions* of these active substances in water. Shellack emulsions show this effect in common with those of other resins, although the shellack solutions exhibited only a very feeble action. On filtering mastix emulsions through an earthenware filter the clear filtrate was found to show scarcely any decrease of surface-tension with time. It is concluded that the effect in the case of emulsions may be as much due to suspended particles as to matter really in solution. The paper closes with remarks on the theory of butter-making. This process is attended with the continual *formation* and *contraction* of new surfaces, whereby the *solid* particles (fat globules) contained in these surfaces (bubbles) are brought into contact and united to form stiff or viscous membranes. It is pointed out that the formation of butter occurs at a temperature at which the butter is solid. The lumps of butter are thus conglomerates of solidified bubbles, which agrees with their microscopic appearance. Reference is made to analogous phenomena observable in the case of resin and other emulsions. F. G. D.

3. *Formation of Liquid Drops and Tate's Law.* **Leduc** and **Sacerdote.** (Comptes Rendus, 135. pp. 95–98, July 15, 1902.)—This is an experimental investigation of the relationship between the radius of the tube and the weight of the drop emitted. It is found that Tate's law, viz., for the same liquid the weight of the drop is proportional to the radius of the orifice, is satisfied for radii from 0·5 to 1·5 cm., but that it becomes less and less true as this range is departed from on either side. For orifices greater than 2 cm. the weight of the drop is practically constant. Tate's law is theoretically derived on the supposition that the surface-tension is the only molecular force acting; but it is pointed out that cohesion plays a large part in the phenomenon. An illustrative curve is given. J. W. P

4. *Variation with Temperature of the Surface Energies and Densities of Liquid Oxygen, Nitrogen, Argon, and Carbon Monoxide.* **E. C. C. Baly** and **F. G. Donnan.** (Chem. Soc., Journ. 81. and 82. pp. 907–923, July, 1902.)—The method employed was that of measuring the elevation in capillary tubes. For the temperature measurement a Callendar's compensated constant-pressure hydrogen thermometer was used, and the radii of the capillary tubes employed were determined by the capillary rise of benzene and ethyl acetate. In the readings for the liquid gases a telescope and micrometer were employed, 80 divisions of the micrometer corresponding to 1 mm. Tables of values for each of the above liquid gases are given, showing temperature and density, temperature, surface-tension, and molecular surface energy. Empirical formulæ and curves expressing these results are given. J. W. P.

5. *Plane Toothed Wheels.* **C. Burali-Forti.** (Accad. Sci. Torino, Atti, 37. 11a. pp. 253–273, 1901–1902.)—The object of this paper is, in the author's words, to determine two coplanar lines which remain always in contact under determinate rotations (or translations) in their plane round distinct centres. Let A and B be two distinct centres, and let A and B respectively denote the vectors from the origin to A and B. A and B will be the centres of two toothed wheels. Let the radius from A turn with angular velocity $\alpha = d\phi/dt$, that from B with velocity $\beta = d\psi/dt$. The two wheels have rotation in the same or opposite direction according as α/β is positive or negative. If C is the centre of gravity of masses, α and $-\beta$ placed respectively at A and B, and if C denote the vector from the origin to C, we have $C = (\alpha A - \beta B)/(\alpha - \beta)$.

The general theorem of the paper is as follows:—P and Q are points in the plane, both functions of the single variable u. As u varies P and Q describe two curves. Then the loci of P and Q are called *conjugate profiles of the wheels of centres* A *and* B, and for any the same value of u, P and Q are *corresponding points* in the loci, if the following conditions are satisfied, namely: (1) The position which P attains by rotation through an angle ϕ about A coincides with the position which Q attains by rotation through an angle ψ about B. (2) The tangents of the two profiles at their common point coincide at every instant. These conditions are expressed by the equations in quaternion notation—

$$\mathrm{A} + e^{i\phi}(\mathrm{P} - \mathrm{A}) = \mathrm{B} + e^{i\psi}(\mathrm{Q} - \mathrm{B}), \quad (e^{i\phi}d\mathrm{P})(e^{i\psi}d\mathrm{Q}) = 0.$$

It is shown that if $\alpha = \beta$, then the common normal to the two curves at the contact point is parallel to A B; if $\alpha + \beta$, the common normal passes through C. The general theory being thus explained, the author proceeds to consider special cases. (1) Toothed wheels to a point—otherwise shaft or lantern wheels—*i.e.*, when the teeth of wheel B reduce to a point. (2) Ordinary toothed wheels as to which it is proved that given the profile Q, we obtain the conjugate profile P as the envelope of the profiles of the wheel A conjugate to the points Q, considered as profiles of the teeth of wheel B. In a special case Q describes a right line, $\mathrm{Q} = \mathrm{B} + k\mathrm{I} + ue^{i\theta}\mathrm{I}$, in which I is unit vector parallel to AB, and k, θ are constants. The author next considers the case of toothed wheels at given pressure. The problem: Given A B and the functions ϕ ψ θ, to determine two conjugate profiles P Q, enables us in its solution to construct a system in which the pressure shall be constant in time, or vary according to any given law. The last case considered is that called "Cremaliere," in which to a rotation ϕ round A there corresponds a translation of Q parallel to the vector iI. S. H. B.

6. *Motion Parallel to a Plane of a Fluid Containing n Elementary Vortices.* **E. Laura.** (Accad. Sci. Torino, Atti, 37. 12 and 13a. pp. 321–328, 1901–1902.)—The motion depends on the system of n differential equations of the first order—

$$m_i \frac{dx_i}{dt} = \frac{d\mathrm{P}}{dy_i}, \quad m_i \frac{dy_i}{dt} = -\frac{d\mathrm{P}}{dx_i}; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathrm{I}.$$

$$\text{where } \mathrm{P} = -\frac{1}{n}\Sigma m_i m_k \log \rho_{ik}$$

These reduced to the Hamiltonian form are—

$$\frac{dx_i}{dt} = \frac{d\mathrm{P}}{dp_i}, \quad \frac{dp_i}{dt} = -\frac{d\mathrm{P}}{dx_i}; \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \mathrm{II}.$$

obtained from the former system by writing $\frac{x_i}{m_i}$ for x_i, and p_i for y_i. The integration of this system is equivalent to that of the partial differential equation of the first order—

$$\frac{df}{dt} + (\mathrm{P}_1 f) = 0$$

in which P is an arbitrary function of ρ, and—

$$(\mathrm{P}_1 f) = \Sigma_i \Sigma_k \left\{ \left(\frac{x_i}{m_i} - \frac{x_k}{m_k}\right)\left(\frac{1}{m_i}\frac{df}{dp_i} - \frac{1}{m_k}\frac{df}{dp_k}\right) - (p_i - p_k)\left(\frac{df}{dx_i} - \frac{df}{dx_k}\right) \right\} \frac{d\mathrm{P}}{d\rho_{ik}} = 0.$$

The integrals independent of the time are found by making $df/dt = 0$, that is, from $(P_1 f) = 0$, and therefore by reducing to zero the above expression within the brackets $\{\}$.

There are three known systems of integrals, viz., $F_1 = \Sigma x = \text{constant}$; $F_2 = \Sigma mp = \text{constant}$; $F_3 = \Sigma m\left(\frac{x^2}{m^2} + p^2\right) = \text{constant}$. The fourth integral $\Sigma\left\{\left(\frac{x_i}{m_i} - \frac{x_k}{m_k}\right)^2 + (p_i - p_k)^2\right\}$ is shown not to be independent of these three.

The general integral is then $F(F_1, F_2, F_3)$, where F denotes an arbitrary function.

Referring to the works of Sophus Lie (Begründung einer Invarianten-Theorie der Berührungs Transformationen, &c.) the author concludes that the sum of the products of the squares of the distances between the vortices taken two and two together by the intensities of the two vortices in question is invariable with the time. S. H. B.

7. *Theory of Pneumatic Masses.* **E. Ovazza.** (Accad. Sci. Torino, Atti, 37. 11a. pp. 281–291, 1901–1902.)—The author proposes to avoid the inconveniences attending the use of metallic masses, when subjected to frequent or continuous deformations, by using pneumatic masses. He assumes for this purpose a cylinder closed at one end in which works an air-tight piston, so that beneath it there is always the same mass of air or other fluid, to which apply the laws of elasticity of a perfect gas. If l be the distance of the piston from the base of the cylinder when the pressure of the contained fluid is equal to the external pressure p_0 (that is the natural length), and if the piston receive displacement Δl outwards, the tension p of the included fluid is diminished, from p_0 to $p_0(1-\sigma)$. If we neglect the deformation of the walls of the cylinder, and suppose the physical transformation of the included air or fluid to be politropical, we find $p_0 l_\lambda = p_0(1-\sigma)(l+\Delta l)_\lambda$, (1) where λ is a constant equal to 1·41 for isothermic transformation, that being the ratio of the two specific heats. In general $1 < \lambda < 1{\cdot}41$. If $\Delta l = \epsilon l$, the cylinder of air is shown to have suffered dilation ϵ per unit of volume. The hyperbola $yx^\lambda = 1$ represents the equation $(1-\sigma)(1+\epsilon)^\lambda = 1$, when it is referred to axes ϵ and σ drawn parallel to x and y from the point $x = y = 1$. The author next considers the case in which the walls of the cylinder undergo elastic deformation, and discusses the maximum energy which can be accumulated in the form of work done in deformation. Comparing the pneumatic with a metallic mass, he shows the distinction between the two types. In case of the metallic mass, equal and opposite forces correspond to equal and opposite values of ϵ. In case of the pneumatic mass this simple law does not hold. The author next treats of a pneumatic mass with a double piston (two chambers) with reference to Chenot's atmospheric hammer, and shows how symmetrical results may be obtained analogous to those obtained for a metallic mass. This case of the double piston also admits of being treated symmetrically. The maximum of energy or work done in deformation in case of the double piston is shown to depend on the resistance of the walls. An important practical application is described—that, namely, of transmission of force, with reference to the works of Chenot, Schmid, Arus Longworth, &c. The difficulty which occurs in imparting motion to a machine by the strokes of a rectilinear shaft is avoided by the use of the pneumatic system. S. H. B.

8. *Recent Determinations of Gravity in the Atlantic Ocean.* **P. Pizzetti.** (N. Cimento, 4. pp. 5–10, July, 1902.)—For a complete knowledge of the form of the earth, determinations of the value of g must be made at sea as well as on land. The pendulum method is suitable on land, but at sea it has to be replaced by the hypsometric method. As shown by Mohn in 1899, the pressure of air as deduced from the boiling-point of water is independent of the value of g, while the barometric height is inversely proportional to g, so that a comparison of the hypsometer and barometer enables the changes in the gravity constant to be followed. If b is the air pressure deduced from the boiling-point, according to Wiebe's tables, b the barometric pressure, then $B - b = b(g/G = 1)$, where G is the value of gravity at the sea-level in latitude 45°. Dr. Hecker was commissioned by the Geodetic Institute of Berlin to apply the method, at fifty-one different points, during a voyage by one of the Hamburg-South American steamers to Rio. The results are given in Prof. Helmert's publication under the title "Bericht über die Thätigkeit des Centralbureaus der Internat. Erdmessung in Jahre 1901" (Berlin, 1902): these results do not contradict the hypothesis that on the high seas the values of g are not systematically different from those given by the theoretical formula.

D. H. J.

9. *Pyrheliometric Measurements made on Mount Cimone in the Summer of* 1901. **C. Chistoni.** (Accad. Lincei, Atti, 11. pp. 479–486, May 31; and pp. 539–541, June 15, 1902.)—The pyrheliometer used was a modified form of that of Violle and gave results which were found to be quite satisfactory when compared with those given by an Ångström instrument; the data for this comparison, together with relevant meteorological records, are given in the second paper referred to above. The space between the concentric spheres of the pyrheliometer was filled with paraffin. The entrance tube for the solar rays was rather longer than in Violle's arrangement, and attached to it at right angles were two discs—the one nearer the sun containing three holes through which images of the sun were cast on three points of reference on the second disc when the instrument was in position.

The experiments consisted in reading the steady initial temperature, t_0, of of the thermometer (of which the water-equivalent had been determined) placed in the centre of the inner sphere; then reading the temperature t_1, after one minute's, and again the temperature t_3, after three minutes' exposure to the sun's rays. The calculation from the observations, of the calorific energy q which falls on a surface of 1 cm.² at right angles to the direction of the rays, is made by Chwolson's method (Repertorium für Meteorologie, xv., St. Petersburg, 1892): $q = m \,.\, \theta \,.\, c/s$, where c is the water-equivalent of the thermometer, s the cross-section of the beam of light falling on the thermometer, $m = \frac{hS}{c}$ (S is the surface of the bulb of the thermometer; h is the amount of heat given out by radiation during a rise of 1° temperature on the thermometer), $\theta = T - t_0$ [T is the stationary temperature reached by the thermometer as the result of the heating due to the solar rays and the cooling due to radiation from the thermometer bulb]. D. H. J.

10. *Sampling Bottle for Sea-water.* **J. Richard.** (Comptes Rendus, 134. pp. 1385–1387, June 9, 1902.)—Since it has been ascertained that sea-water does not, at great depth, contain considerable quantities of gases under high pressure, as had been assumed, the sampling vessels need not be particularly strong, nor large. The author's reversible bottle has a capacity of 315 c.c. While it descends, the water passes right through the bottle; the two corks above and below, are connected by a rod on which rides the reversible thermometer. This thermometer starts the reversing motion; the whole

apparatus weighs less than 2 kg. The Prince of Monaco has fixed eight of these apparatus, at distances of 200 m., to the same wire; they all operated, except the one nearest the surface. H. B.

11. *Perspective Nephoscope.* **C. Marangoni.** (Revista Sci.-Industriale, 34. pp. 77–80, June 15, 1902.)—The author presented last year to the Exposition at Novara a description of a nephoscope to which a camera obscura was attached with the necessary arrangements for observing cloud movement. On account of the expense, &c., the author has now dispensed with the camera obscura and made the instrument a direct-vision one. The modified apparatus consists of a trapezium-shaped table, capable of movement in azimuth and vertically, and provided with a level and mariner's compass. At one side of the table (which is mounted on a tripod) is a vertical pane of glass, on which is marked a horizontal graduated line; in front is a sight through which the clouds are viewed. The position of the clouds is marked from time to time on the pane, and by the laws of perspective the exact movement of the clouds is thence determined. D. H. J.

12. *Rate of Propagation of an Earth-Tremor.* **R. F. Gwyther.** (Manchester Lit. and Phil. Soc., Mem. 46. 6. pp. 1–12, June, 1902.)—Rayleigh (Proc. Lond. Math. Soc., 17, 1885), in a paper on waves propagated along the plane surface of an elastic solid, has shown that the rate of propagation is definite and unique, provided the amplitude of displacement decreases with increasing depth according to the simple exponential law. The author investigates the conditions which lead to this unique definite rate of propagation, and connects it with the absence of infinities from the possible forms of solution, and the consequent absence of discontinuities in the stresses either within the substance of the earth or upon its surface.

W. S.

13. *Martinique Eruption.* **G. Dary.** (Électricien, 23. pp. 6–10, July 5, 1902.)—The suddenness of the deaths seems to have been due to electric discharges, not to poisonous gases or to asphyxiation. A. D.

14. *Volcanic Eruption in Martinique, May* 8, 1902. **Thierry.** (Comptes Rendus, 135. pp. 71–72, July 7, 1902.)—The author saw the eruption from a distance of about 8 km., as the crow flies. The air was remarkably clear after a terrific thunderstorm during the night. The smoke over the crater was not grey as usual, but formed a compact white mass, like an immense cauliflower; this shape of the cloud the author noticed again on the days of the great eruptions on May 20 and 26. Smoke then issued from six more points in a row; incandescent stones and rocks were thrown up to heights of 50 and 100 m. under tremendous roar; suddenly a grey cloud, furrowed with countless lightning-flashes, came down like a wall. The whole phenomenon did not last more than three minutes; no mud was ejected that day. H. B.

15. *The St. Vincent and Martinique Eruptions.* (Monthly Weather Rev. 30. pp. 267–269, May, 1902.)—The two stations of the U.S. Weather Bureau nearest to Martinique are at Bridgetown, Barbadoes, and at Basseterre, St. Kitts. The paper reproduces extracts from O'Donnell's diary at Bridgetown. Before the news of the eruption of the Souffrière on St. Vincent, supposed to

have occurred at 12.30 p.m. on May 7, reached Bridgetown, 100 miles further east, unusual phenomena were observed at the latter place. An explosion was heard at 1.47 p.m., dust fell at 2 p.m., distant thunder was noticed at 3.45 p.m., lightning from 4.15 to 6 p.m. The lightning seemed to emanate from a disc in the west, about 20 in. in diameter, resembling a searchlight of enormous power. The barograph shows jars at 2 and 3 p.m. E. H. Hobbs reports on the Richard barograph waves and other features noticed up to June 8 on St. Kitts. The paper also contains extracts from observations made at other stations and on ships. H. B.

16. *Heights of Sunset After-Glow in June and July*, 1902. **A. S. Herschel.** (Nature, 66. pp. 294–296, July 24, 1902.)—Description of the remarkable after-glows. The finest display occurred on June 26, but no green coloration was observed in the moment of sunset. The apparent elevation of the layer of dust air to which the author is inclined to ascribe the phenomenon, did, in some cases, not much exceed 5 miles, the height of the simultaneous cirrostratus clouds, whilst considerably higher elevations were generally assumed for the Krakatoa sunsets of 1883–84, to which the author refers. H. B.

17. *Use of Rockets against Storms.* **E. Vidal.** (Comptes Rendus, 135. pp. 92–93, July 15, 1902.) (Extract.)—The author presented to the International Congress [Lyon, 1900], for the protection of property against the ravages of storms and particularly of hail, a detailed account of his successful experiments with rockets. It was found possible in clear, cloudless weather to produce annular clouds, and in very cloudy weather to obtain clear, circular spaces in the sky; rain, wind, electrical discharges, could be promptly moderated or prevented, and fields could be protected from hailstones while the neighbouring unprotected crops were destroyed. D. H. J.

18. *Winds and Rainfall of New Haven, Conn.*, 1873–1900. **T. H. Davis.** (Monthly Weather Rev. 30. pp. 261–264, May, 1902.)—The paper deals with the frequency of the wind directions and the rainfall in tables and curves for yearly and monthly averages. The average annual rainfall is 47·38 in. H. B.

19. *Average Annual Precipitation in the United States*, 1871–1901. **A. J. Henry.** (Monthly Weather Rev. 30. pp. 207–213, April, 1902.)—Tables of statistics from 734 stations. The records cover more than 30 years in 140 cases, between 20 and 30 years in 183 cases, 10 and 20 in 329, and less than 10 years in 82 cases. The tables state latitude and longitude and elevation of the station, annual precipitation, and period covered. H. B.

20. *Statics and Kinematics of the Atmosphere in the United States.* **F. H. Bigelow.** (Monthly Weather Rev. 30. pp. 163–171, April; 250–258, May; and pp. 304–311, June, 1902.)—A continuation of the articles mentioned in Abstracts Nos. 1503, 1997, 2021 (1902). The first two papers review the "canal" theories of Ferrel and of Oberbeck on local and general circulation. Both start with a local overheated mass of air, rising through its own buoyancy. Ferrel assumes a fixed cylindrical boundary about his cyclone (whose circulation is counter-clockwise for a warm centre and clockwise for a cold centre), which is surrounded by a pericyclonic ring (circulation in the opposite sense), the two portions being separated by a surface where the gyratory velocity vanishes. Oberbeck does not assume any external boundary to the circulating mass of air, but a discontinuity in the vertical component at the distance where the gyratory velocity about the axis is maximum. Both

these theories divide the cyclone into two special parts ; neither accounts for the anticyclone nor for the calm in the centre of a hurricane, nor do cloud observations confirm these views. The author points out that there is a decided eastward drift at elevations of 2 or 3 miles over the central and eastern United States. Further, a slight warm drift to the north in all strata, increasing a little with elevation, and a cold southward current to the east of it. In these respects Asia differs from North America, because the Himalaya Mountains stop these currents. The streams are shallow, but extend over thousands of miles. The currents interact less by position than after the manner of couples. The author thus accentuates horizontal convection ; his vertical cyclone component is very small. The cyclone tends to rotate along the front of a high pressure area towards the north ; as its top is fastened by the eastward drift at the 4,000 m. level, the storm advances towards north-east in the central and eastern United States. The different direction in the Caribbean Sea (first to the west) is ascribed to the anticyclone in the southern portion of the North Atlantic. Temperature equilibrium is probably restored when the 5,000 m. level is reached. The upper cirrus clouds precede the cyclone as forerunners. The author himself characterises the problem as exceedingly complicated. Cyclones, hurricanes, and tornadoes differ only in dimensions and details; in the latter two, vertical convection plays an important part. The last article discusses mathematical formulæ useful in meteorology, the general equations of motions and aqueous-vapour problems.
H. B.

21. *Relation of the Sun-spot Cycle to Meteorology.* **C. G. Abbot.** (Monthly Weather Rev. 30. pp. 178–181, April, 1902.)—The author discusses on general lines the ways in which sun-spots might influence terrestrial meteorology. Records of solar radiation (Crova's records from Montpellier) do not show any 11-years period, nor could they be expected to do so. Yet there might be spectral rays of certain wave-length, to which the earth's atmosphere is quite transparent ; bolometer researches in this direction are being carried on at the Smithsonian observatory and should be made at high altitudes in the Tropics. The paper further deals with Lockyer's views on the interconnection between sun-spots and faculæ and prominences, and with Langley's and Halm's views on the influence of solar atmospheric absorption. H. B.

22. *Revision of Wolf's Sun-spot Relative-Numbers.* **A. Wolfer.** (Monthly Weather Rev. 30. pp. 171–176, April, 1902.)—The paper contains a copy of the author's revised edition of Wolf's tables (which was to be published in the Astronomische Nachrichten cxiii.) in which older observations, notably those made at Krems Münster 1802–1830, are also worked up. The table covers the period 1749–1901, and gives values for each month of those years, both observed relative-numbers (Table 1) and smoothed numbers (Table 2). The editor of the journal has reproduced these two tables in graphic form. Smaller tables, 3 and 4, give the dates and intervals of sun-spot maximum and minimum. The interval minimum to minimum varies between 9 and 13·5 years ; the ratio a/b ($a =$ interval maximum to following minimum, $b =$ interval minimum to maximum) between 0·4 and 1·65. The author finds no indication of Lockyer's period of 35 years, nor of Halm's period for a/b. Yet the variations of a and of a/b seem to proceed parallel with the intensity of the development of the spots through each 11-year period in that a maximum follows a minimum quicker in proportion as the maximum is higher.
H. B.

23. *Relationship of Corona and Chromosphere.* **H. Deslandres.** (Comptes Rendus, 134. pp. 1285–1288, June 2, 1902.)—Photographs of the Corona obtained in Sumatra on the occasion of the total solar eclipse of May 18, 1901, exhibit many features of close relationship to others shown on photographs of the chromosphere taken at Meadon with the spectroheliograph during the time at which the eclipse was occurring. The chief feature was the presence of a brilliant prominence in the N.E. quadrant, about latitude 9°, which was in great contrast to the usual smaller markings seen during sun-spot minima. This prominence appears to have been immediately in the neighbourhood of the great coronal disturbance which has been noted by most of the observers who obtained successful photographs of the eclipse. Further, the chief coronal streamers are apparently related to the prominences whose bases are very luminous, rather than to those of greater height. The instrument which is now in use at Meadon for giving the radial velocity of the chromosphere was not available during the above eclipse. C. P. B.

24. *Spectroscopic Determination of Rotation Periods of Planets.* **H. Deslandres.** (Comptes Rendus, 135. pp. 228–231, July 28, 1902.)—The method employed by the present author and Keeler for obtaining the rotation period of planets by measuring the inclination of the spectrum lines is extended to the examination of the fainter objects, such as Uranus and Neptune. In this case either of two plans may be adopted. The objective giving the image of the planet on the slit plate may be selected of such short focus that practically all the light from the disc enters the slit, and of course the foci and apertures of collimator and telescope must be adjusted accordingly, so that all the light traverses the prism train.

A second mode of procedure is to photograph the spectrum by means of a large objective prism outside the objective of the camera, providing for a reversal of the apparatus round the axis of sight pointing to the star.

The method is stated to be at least as accurate as that of observing the movements of spots on the surfaces of the planets. C. P. B.

25. *Origin of Sun Protuberances.* **H. Julius.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 126–135, June 28, 1902.)—On the principle of anomalous dispersion, a satisfactory idea of the physical state of the sun may be formed, and the theory of protuberances may be based on the following hypothesis: The whole of the chromosphere with its protuberances consists of a system of waves and vortices, being visible, on account of the anomalous dispersion of the light of the photosphere, over a certain distance from the edge of the sun. A. G.

26. *Spectroscopic Results from Solar Eclipse of May* 18, 1901. **W. J. Humphreys.** (Astrophys. Journ. 15. pp. 313–332, June, 1902.)—Six films were taken during the eclipse at Sumatra under the auspices of the naval observatory, U.S.A., by means of a concave grating of 30-ft. focus. A table is given of the wave-lengths of all the lines obtained compared with Rowland's measurements, and also tables showing the elements present with the numbers of the lines establishing them, and also the approximate heights of the various elements as shown by the lengths of the crescents on the plates. The measurements cover the region from $\lambda = 3118$ to $\lambda = 5204$. E. C. C. B.

27. *New Algol Variable.* **E. C. Pickering.** (Astrophys. Journ. 15. pp. 343–346, June, 1902.)—Examination of the series of photographs obtained

with the 8-in. Draper Telescope at Harvard College Observatory has resulted in the detection of an interesting new variable star of the Algol type. The star is the *north-preceding* component of + 43° 4101. Its position for 1901 is R.A. = 21h. 55m. 2; Decl. = + 45° 52′. This new variable is shown on 388 plates, exposed at various times during the period 1889–1902. A table is given showing the details of the variation in brightness. For 28 days the full brightness is maintained, the photographic magnitude being 8·9. About a day before the minimum it begins to diminish, attaining the magnitude of 9·0 about $1^d{\cdot}05$ and 11·5 at $0^d{\cdot}43$ before minimum. The light remains constant for more than half a day, with magnitude 11·6. The time of increase is more uncertain, but it is apparently not very different from that of decrease. The whole cycle is completed in the period of 31·4 days, which is more than three times as great as that of any other variable of this type at present known. The duration of minimum is two days, which is also very large, that of S Cancri being only 0·9 days. C. P. B.

28. *The Spectroscopic Binary β Cephei.* **E. B. Frost.** (Astrophys. Journ. 15. pp. 340–341, June, 1902.)—This binary possesses a variable radial velocity, and eleven plates were taken with a view of determining the period. The spectrum is of the Orion type, Vogel's Ib class, and in particular of Miss Maury's IIIa class, with β Canis Majoris as the type. The principal lines are due to oxygen, silicon, helium, and magnesium. The radial velocity was found to vary between — 20 and + 11 km., but, owing to bad weather, observations at short intervals have been impossible, and thus the period cannot be accurately determined. E. C. C. B.

29. *Wave-lengths of the brighter Nebular Lines.* **W. H. Wright.** (Astrophys. Journ. 16. pp. 53–59, July, 1902.) — The paper contains the results of certain photographs taken of the spectra of various nebulæ, including that of Orion, tables being given of the wave-lengths found after correction for radial velocity. The author confirms Hartmann's wave-length for the iron line at 4959 [see Abstract No. 1303 (1902)] but does not agree very well as regards the wave-lengths of the two principal nebula lines, as he finds them to be 5006·89 and 4959·05 against Hartmann's 5007·04 and 4959·19. Keeler's values, when corrected for the error in the wave-length of the iron line, are the same as those of Hartmann's. E. C. C. B.

30. *Kathodic Radiation and Nebulæ.* **H. Deslandres.** (Comptes Rendus, 134. pp. 1486–1489, June 23, 1902.)—The paper is chiefly in the form of a reply to Nordmann's [see Abstract No. 2204 (1902)] criticism of a former paper by the present author. The main objection of Nordmann to the kathode theory of Deslandres was that these rays, having no action on gaseous particles, could not produce the observed phenomena. Deslandres answers this by doubting the absolute gaseous nature of nebulæ, as evidence is available in many of them that a continuous spectrum is in existence. The same applies to the solar corona. C. P. B.

31. *Nebula surrounding Nova Persei.* **L. Bell.** (Astrophys. Journ. 16. pp. 38–42, July, 1902.)—The author discusses the various theories which have been put forward to account for the peculiar changes in brightness and position of the nebulosity round the Nova. The view receiving most support is that which considers the luminous disturbance as a secondary result of radiated electro-magnetic strains, of somewhat similar nature to those manifested during solar storms. [See also Abstract No. 1300 (1902).] C. P. B.

32. *Zodiacal Light.* **L. Décombe.** (Comptes Rendus, 134. pp. 1352–1353, June 9, 1902.)—The zodiacal light, considered as the remains of the solar-system nebula, extends beyond the terrestrial orbit, and is of the form of a flat disc whose plane coincides sensibly with that of the planetary orbits. If electricity had been initially placed out of equilibrium in such a system, it must execute oscillations, the damping of which must be very slow. If the sun be at a node of electric oscillations, and the (circular) periphery of the system be a nodal line, the period will be the radius of the disc ÷ the velocity of propagation. If the propagation have a velocity of 300 km., corresponding to a mass of free ions, the period of oscillation would be about eleven years. A. D.

REFERENCES.

33. *Reduction of the Observed Values of Gravity at the Earth's Surface to a Common Level. I.* **F. R. Helmert.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 36. pp. 843–855, July 17, 1902.)—This is a critical discussion of the method of reduction introduced by Bouguer, which in its original form supposed the part of the earth's crust above sea-level to be removed; in its modified form, to be condensed at sea-level. The author considers also the recent endeavours to continue the gravitational potential within the earth's crust; here hill and valley are replaced by a uniform, nearly horizontal surface consisting of layers of uniform density. W. S.

34. *Projection of Convection Streams in Fluids.* **P. Lewis.** (Phys. Zeitschr. 3. pp. 377–378, June 1, 1902.)—The "schlieren-method" of Töpler can be employed to give a representation of the variations in density (1) over a plate heated by a burner, or (2) in a vessel containing a fluid which is heated. P. E. S.

35. *Finding the Velocity of Projectiles.* **H. G. Ticehurst.** (Feilden, 6. pp. 504–508, June, 1902.)

36. *Analysis of Constituent Elements of Work in Inanimate Motors.* **A. Chauveau.** (Comptes Rendus, 134. pp. 1177–1179, May 26; 1266–1271, June 2; and pp. 1399–1405, June 16, 1902.)

37. *Meteorological Observations Made at the Fortifications of St. Maurice during the Year* 1901. **R. Gautier.** (Archives des Sciences, 13. pp. 490–511, May, and pp. 581–595, June, 1902.)

38. *Instrumental Errors in Star Photographs.* **C. Trépied.** (Comptes Rendus, 134. pp. 1097–1100, May 12, 1902.)—An examination of the deformation of the rectilinear co-ordinates of stars measured from plates taken with an instrument whose axis slightly deviates from the true pole. C. P. B.

LIGHT.

39. *Electric Lamp for Microscope Illumination.* **M. M. Metcalf.** (Science, 15. pp. 937–939, June 13, 1902.)—At the Women's College of Baltimore nearly white light is obtained by using 40-volt lamps on a 50-volt current. About 25 per cent. of the lamps are renewed annually. 45-volt lamps last longer and give a much less yellow light than the proper 50-volt lamp. The bulb is of ground glass, and this is mounted in a reading globe with mirror back and ground-glass front : this gives a very even field of light. A. D.

40. *Sizes of Water Particles Producing the Coronal and Axial Colours of Cloudy Condensation.* **C. Barus.** (Phil. Mag. 4. pp. 24–29, July, 1902.)—The author gives a table containing a summary of his data for the sizes of water globules producing coloured cloudy condensation either by the diffraction of diverging rays or by absorption of the strictly axial pencil. The method of work has been described in earlier papers [see Abstracts Nos. 1669 (1901), and 691 and 1092 (1902)]. With regard to the two sets of colours, it appears that the coronas must in large measure be diffraction phenomena ; the axial colours cannot be thus explained, but seem to be due to some unknown kind of absorption. W. C. H.

41. *Resolving Power of Objectives.* **J. D. Everett.** (Phil. Mag. 4. pp. 166–171, July, 1902.)—The paper, which is intended to supplement two previous ones by Rayleigh [Phil. Mag. 8, p. 266, 1879 and 42, p. 167, 1896], finds, for the least distance between the components of a double star, an expression which agrees with Dawes's value of 4·56 sec. ÷ diameter of objective in inches. The equation found is then transformed by using Abbe's "sine condition" and applied to the case of the microscope, and the value found for the distance between points which can be barely separated, is shown to agree with that usually adopted, *e.g.*, Abbe's form : wave-length ÷ twice the numerical aperture. It is shown that blurring due to refraction may be reduced to a minimum by focussing the source on the object, and Hockin's proof of the sine condition is appended as being the simplest. G. E. A.

42. *Refractivity of Solutions in Carbon Disulphide.* **C. Forch.** (Ann. d. Physik, 8. 3. pp. 675–685, June, 1902.)—The difference, $\mu_2 - \mu_1$, between the refractive indices of solution and solvent is measured by observing, in a telescope, the deflection on a scale, caused by interposing a trough containing the two liquids separated by a diagonal partition. The dissolved substances were sulphur, naphthalin, ethyl-ether, chloroform, paraffin oil and castor oil ; and tables are given with the values of $\mu_2 - \mu_1$, for varying strengths of solution. For naphthalin $\mu_2 - \mu_1$, is almost zero ; whilst for chloroform it is almost in exact proportion to the percentage strength of the solution. For the others $\mu_2 - \mu_1$ increases more slowly as the concentration increases. G. E. A.

43. *Stereoscopes for Large Pictures.* **H. Krüss.** (Phys. Zeitschr. 3. pp. 361–365, May 15, 1902.)—Two stereoscopes are described which are designed for the examination of radiograms of large size. In one, reflection is employed ; the other obtains the necessary width of field by means of achromatic prisms. The former is on the plan of Helmholtz's stereoscope, and both can be used with pictures up to 40 × 50 cm. in size. G. E. A.

44. *Stereoscopic Method of Photographic Surveying.* **H. G. Fourcade.** (Nature, 66. pp. 139–141, June 5, 1902. Paper read before the South African Philosophical Society, Oct. 2, 1901.)—Photographs are taken at two points with a surveying camera, the plates being exposed in the vertical plane passing through both stations. The developed plates, or positives, from them, being then placed in a stereoscopic measuring machine which combines the pictures, the three co-ordinates of any point may be found from the readings of micrometer screws, combined with those of a *réseau* or graduated back frame, by direct multiplication or division of plate constants depending on camera focal length and length of base. A theory of the method is given in which the co-ordinates of a pt. are expressed in terms of the base length and another constant—the stereoscopic difference. Descriptions of the camera and of the method of measuring the plates are given. The effective range of the instrument is put at about 5 miles, and the method would be of particular advantage in the mapping of large areas of mountainous country. G. E. A.

45. *Scale of Interference Colours.* **C. Kraft.** (Acad. Sci. Cracovie, Bull. 5. pp. 310–353, May, 1902.)—The colours here treated are those displayed by thin films, or by crystalline laminæ in the polariscope. The author gives tables showing the difference of path in quartz corresponding to each interference tint, the luminous source being white. He employed several different kinds of white light, tabulating the results for each separately. Similar investigations have been published by Wertheim in 1854, and by Rollett in 1878, but their results differ from one another considerably. To produce the colours, a Biot's compensator was employed, composed of three quartz plates cut parallel to the optic axis, two being slightly wedge-shaped so that the thickness could be varied at will. The compensator was immersed in essence of anise, which has nearly the same index as quartz, and placed between two nicols. The spectra of the colours were examined with a Rowland's grating. Very strong light was employed, as it was desirable to make the dark bands narrow to enable the minima to be estimated accurately. The width of a band in the first order was under $0{\cdot}004\,\mu$. In the first table all numbers in a horizontal line relate to one given thickness of quartz. The colours observed with crossed nicols are given in succession in the first column up to those of the third order. The second column gives the wavelength of the minimum observed in the spectrum, the third column the corresponding difference of path. The seventh, sixth, and fifth columns give these data for parallel nicols. The middle column gives the calculated difference of path in quartz for wave-length $0{\cdot}550\,\mu$. This table is repeated for five other different sources of white light. To facilitate comparison, the results are also exhibited graphically. Another table gives the correspondence of the interference colours to thicknesses of a layer of air with normal incidence, as deduced from calculation. A. E.

46. *Discrepancy between Grating and Interference Measurements.* **A. Perot** and **C. Fabry.** (Astrophys. Journ. 16. pp. 36–37, July, 1902.)—This is a reply to L. Bell. The authors complain of certain criticisms [see Abstract No. 1687 (1902)] made on the discrepancy between grating and interference measurements which was especially evidenced in a paper by the authors [see Abstract No. 675 (1902)]. Bell pointed out that there is a considerable difference between the values of the wave length of the green cadmium line, which the authors used, as found by Michelson and by Hamy. To this the authors point out that different sources were used in each case which probably would give slightly different wave-lengths. As regards the comparison between Rowland's and their measurements the authors point out that the one set is relative to the solar spectrum while the other refers to artificial sources, and that the difference between the two is in the direction and of the order that one would expect. E. C. C. B.

47. *Rapidity of Combustion of Photo-Powders.* **A. Londe.** (Comptes Rendus, 134. pp. 1301–1303, June 2, 1902.)—To test the duration of the light from magnesium flash powders used in photography, a moving plate was exposed by means of a narrow aperture, in front of which vibrated a fork of frequency 1000. The powders in general use instead of giving, as was imagined, exposures of 1/100 to 1/150 sec., burned for 1/4 to 1/20 sec., some for 1/25, and only one for 1/30 sec. The rapidity of combustion was greatest when the powder was heated by means of a pt. fuse wire or by fulminate of mercury. By employing an apparatus in which twelve photos could be taken at intervals of 1/100 sec., it was shown that the actinic power of the light reaches a max. in 2/100 to 3/100 sec., that it lasts for 5/100 to 6/100 sec. and then diminishes. G. E. A.

48. *Physiological Photometry.* **G. M. Stanoiévitch.** (Comptes Rendus, 134. pp. 1457–1458, June 16, 1902.)—Apparatus for reducing, with iris diaphragm and otherwise, the illumination from a source of light to the minimum perceptible amount : the graduation shows the original intensity. Apparatus here described as for high-power sources of light ; and it is a modification of low-power apparatus described in the Comptes Rendus, August 5, 1901. A. D.

49. *Absorption and Abnormal Dispersion.* **J. Boussinesq.** (Comptes Rendus, 134. pp. 1389–1394, June 16, 1902.)—Equations of motion being found for the molecules of a medium in a condition to absorb vibratory energy of a definite frequency, and for the ether, an expression for the (refr. index^2) of the medium for an unextinguished ray in terms of the mean index is found which has the same form as that deduced from experimental results. G. E. A.

50. *Double Refraction in Liquids under Stress.* **G. de Metz.** (Comptes Rendus, 134. pp. 1353–1356, June 9, 1902.)—On suddenly separating and restoring two metallic plates immersed in a liquid, double refraction is found to be set up. The following list gives the order of the amount of this double refraction, beginning with the most doubly refractive ; the numbers in brackets give the order of viscosity, the most viscous being No. 1. Gelatine jelly (1) ; Marx's (St. Petersburg) copal varnish (16) ; agar-agar jelly (2) ; Iceland moss jelly (3) ; solution of resin in essence of turpentine (5) ; Marx's dammar varnish (17) ; Marx's picture varnish (13) ; Venice turpentine (6) ; Canada balsam (8) ; duplex collodion 4 per cent. (12) ; Möwe's (Berlin) copal varnish (15) ; Maracaïbo copahu balsam (10) ; very old picture varnish (11) ; solution of dammar in essence of turpentine (7) ; gelatinous silica (4) ; aqueous solution of metaphosphoric acid (9). With the first of these the difference of path is about $0{\cdot}9\,\lambda$; with Canada balsam it is $0{\cdot}03\,\lambda$; below Canada balsam it is too small to be measured, though light comes through. The viscosity is out of relation with the double refractive power ; but the double refractive power falls off or even disappears as the temperature rises. Marx's dammar varnish and copal varnish and collodion remain doubly refracting

for some time, even for some minutes. The first of these is perfectly transparent; the other two are somewhat opalescent; which rebuts Fammann's contention that opalescence, not a liquid crystalline state (Lehmann) is the cause of double refraction in those liquids (chloresteryl benzoate, paranitroxyanisol, paranitroxyphenetol) which present it permanently. A. D.

51. *MacCullagh and Stokes' Elliptic Analyser.* **J. Walker.** (Phil. Mag. 3. pp. 541–549, May, 1902.)—A geometrical proof is given of the formulæ of MacCullagh and Stokes for the use of a plate of mica in conjunction with a Nicol's prism as an analyser of elliptically polarised light. A sphere is found such that any point on it will represent the state of polarisation of a stream of light, the azimuth of its plane of maximum polarisation being half the longitude, and the ratio of the axes of the elliptic vibrations being the tangent of half the latitude of the point; and the polarisation is right- or left-handed, according as the point is in the N. or S. hemisphere. The effect of transmission through a crystalline plate is then represented by three successive rotations. The case of the elliptic analyser then follows, and the method is also applied to Gouy's streams of permanent type in active crystals. G. E. A.

52. *Rotatory Dispersion of Spontaneously Active Compounds.* **C. Winther.** (Zeitschr. Phys. Chem. 41. pp. 161–211, July 8, 1902.)—The author gives the results of the measurements of the optical rotations at different temperatures and for different colours of solid dimethyl-, diethyl-, and dipropyl- tartrates, of tartaric and malic acids and potassium sodium tartrate in aqueous solutions, and of tartaric acid in alcoholic solution. The special ray filters and other apparatus employed and also the methods of measurement are described. The numbers obtained lead to the following conclusions: The three tartaric esters have abnormal dispersion, that is, as the wave-length of the light diminishes, the rotation first increases and then decreases. Expressing the relation of the rotation to the temperature by an interpolation formula, it is found that, for all three esters and for all colours, the rotations have their maximum values at about the same temperature, namely, 149°; the variation of the specific rotations with the temperature is hence expressed by the formula: $(\alpha) = a - b(t - 149)^2$. The relation of the specific rotation of these three esters to the wave-length and temperature is given by the dispersion formula—

$$(\alpha) = \frac{c - d\lambda}{\lambda - e}\left(\frac{f\lambda - g}{\lambda - h} - (t - 149)^2\right)$$

in which λ and t are the wave-length and temperature respectively, and c, d, e, f, g, and h constants; this expression gives values more in accordance with the experimental numbers than are obtained by the Cauchy-Boltzmann formula. The values of the specific rotations of tartaric and malic acids obtained by extrapolation from the rotations of their aqueous solutions show that, in the pure state and at low temperatures, these compounds exhibit normal dispersion, but, as the temperature is raised or the solutions diluted, the dispersion becomes firstly anomalous, and later normal again. The alcoholic solutions of tartaric acid examined show much lower rotations than the aqueous solutions; the maxima on the dispersion curves for the aqueous solutions lie between the light and dark blue, whilst for the alcoholic solutions they are between the red and yellow; with increasing concentration the rotations of the aqueous solutions diminish rapidly, but those of the alcoholic solutions undergo a slight increase. The author classes the three tartaric esters and tartaric and malic acids together in a group, the characteristics being anomalous dispersion and extreme variation of the dispersion with change of temperature, concentration, and solvent. Potassium sodium tartrate, however, is an example of another class of compounds which exhibit normal dispersion and but slight variation of the dispersion with change of temperature and concentration. By measuring the specific rotations of the three alkyl tartrates by the amounts by which the actual values exceed the maximum values, the author obtains numbers to which he gives the name "rational" specific rotations, and which are defined by the expression: $(A)=a-(a)=b(t-149)^2$; denoting also the temperature as measured from the temperature of maximum rotation by the term "rational" temperature (T), the above expression becomes: $(A)=bT^2$. From this "rational" specific rotation a "rational" dispersion coefficient may be derived, and it is found that for the three tartaric esters, tartaric and malic acids, this coefficient is independent of the temperature, and for the homologous esters it appears to have a constant value. T. H. P.

53. *Influence of Certain Acid Oxides on the Specific Rotations of Lactic Acid and of Potassium Lactate.* **G. G. Henderson** and **D. Prentice.** (Chem. Soc., Journ. 81. and 82. pp. 658–663, June, 1902.)—In the search for compounds of the tartar emetic type the authors have examined the effect on the rotation produced by the addition of antimonious, arsenious, and boric oxides to aqueous solutions of potassium lactate and of lactic acid. They find that antimonious oxide is almost insoluble in potassium lactate and produces no appreciable change in the rotation; arsenious oxide and boric acid are, however, easily soluble, and produces changes in rotation in such a way that the maximum changes indicate the formation of a definite arseniolactate, (ASO) $C_3H_4O_3K$, and a borolactate, (BO) $C_3H_4O_3K$ respectively. These results are not to be explained by the assumed liberation of lactic acid by the oxides; it was found that arsenious oxide slightly lowers the rotation of lactic acid, whilst boric acid considerably raises it. D. H. J.

54. *Magnetic Rotation of Plane of Polarisation in an Absorption Band.* **A. Schmauss.** (Ann. d. Physik, 8. 4. pp. 842–846, July, 1902.)—The work here detailed gives experimental confirmation to the following two predictions of the electro-magnetic theory by W. Voigt, viz.:—1. The maximum magnetic rotation in an absorption region is almost independent of the field strength. 2. The *negative* rotation occurring in an absorption band decreases with an increasing field strength. [See also Abstracts Nos. 1791 (1900) and 465 (1902).] E. H. B.

55. *Method and Substances to be Employed in Observing Magnetic Double Refraction.* **Q. Majorana.** (Accad. Lincei, Atti, 11. pp. 463–469, May 31, 1902.)—A supplement to a former paper [see Abstract No. 1844 (1902)]. The author employed an electro-magnet of the Weiss type, with expansions of the form of blunt wedges attached to the poles. At first he experimented with thin transparent iron films on glass, but as these gave no appreciable results, he adopted aqueous solutions of the magnetic substances to be examined. To ascertain the intensity at the centre of the field, the expansions were pierced longitudinally, so as to permit the insertion of a fine tube containing benzol. A pencil of light was sent through this tube and the rotation of the plane of polarisation measured. A table was thus constructed giving the intensity at the centre of the field for various strengths of current. The tube containing the liquid to be studied was placed transversely between the poles, and its ends were closed by two strips of plate glass crossed at 90° to counteract accidental birefringence. The tube was examined between nicols, an arc lamp serving as source. Between the analyser and tube were two glass plates, which could be compressed normally to the optic axis of the system, and could also be rotated. It was found that dialysed iron gave more striking results than ferric chloride. The older it was the better, some freshly procured proving quite inactive. Of commercial varieties Ferro Bravais and Ferro Carlo Erba were satisfactory. Nearly all contained some trace of chlorine. A. E.

56. *Spectra arising from the Dissociation of Water Vapour and the presence of Dark Lines in Gaseous Spectra*. **J. Trowbridge.** (Phil. Mag. 4. pp. 156–161, July, 1902.)—After further investigation the author emphasises still further the fact which he has before stated that water vapour plays a very important *rôle* in glass spectrum tubes when very powerful discharges are employed. The apparatus in use consisted of an induction coil with a liquid break, giving a 30-in. spark in air; a step-up transformer excited by an alternating current producing, with glass condensers of about 0·3 microfarad capacity, discharges 1 in. long and of great body; and a storage battery of 20,000 cells. Using powerful discharges in hydrogen, oxygen, and air, even when the gases are dried with the utmost care, the same spectrum is always obtained, which the author attributes to the dissociation of water vapour. This bright line spectrum at high temperatures is accompanied by a faint continuous spectrum containing dark lines which indicate a selective reversibility in the silver salt of the photographic plate. With a tube filled with pure dry hydrogen, by employing different forms of discharge, the author has obtained the spectra of hydrogen (four line spectrum), sodium, argon, and the dissociated water-vapour spectrum. The appearance of argon convinces the author that his spectra do arise from water vapour. An examination of the spectrum from these discharges between poles under water, showed that it was perfectly continuous, the reason for this being not quite clear. The fact that with high temperature dark lines are obtained on the photographs of the spectra arising from dissociated water vapour, which are due to a photochemical action on the plate, is of exceedingly great importance from an astronomical point of view. Reversal of spectrum lines on a plate does not necessarily mean the presence of reversing layers of cooler gases, but may, in certain cases, be due to photochemical action on the plate. Again the dissociated water-vapour spectrum can entirely mask metallic lines, for no lines due to platinum, copper, silver, aluminium, and iron can be seen when these metals are used as electrodes; the author therefore considers that it may be necessary to modify the nomenclature of the stellar types. Finally, the author considers that his results prove the presence in considerable quantity of water vapour in the sun. [See also Abstract No. 33 (1902).] E. C. C. B.

57. *The Infra-red Spectra of the Metals of the Alkaline Earths*. **H. Lehmann.** (Ann. d. Physik, 8. 3. pp. 643–651, June, 1902.)—The author has measured the spectrum lines of calcium, strontium, and barium by a method described in a previous paper [see Abstract No. 1880 (1901)] between the limits $\lambda = 8900$ and $\lambda = 6500$. His results are given in tables, and compared with some values obtained by other observers and those obtained by calculation from formulæ. E. C. C. B.

58. *Spectra of Potassium, Rubidium, and Cæsium, and their Mutual Relations.* **H. Ramage.** (Roy. Soc., Proc. 70. pp. 303–312, July 29, 1902.)—In a previous paper [see Abstract No. 1685 (1902)], the author pointed out that by plotting oscillation frequencies of the lines in the spectra of the elements against the atomic masses or their squares very interesting analogies between the elements can be shown. The present paper contains more data about the wave-lengths of potassium, rubidium, and cæsium lines than were known before, and the conclusions of the previous paper are amply confirmed. Formulæ are given for the calculation of the convergence points of the series. E. C. C. B.

59. *Spectra of Gases in the Magnetic Field.* **G. Berndt.** (Ann. d. Physik, 8. 3. pp. 625–642, June, 1902. Communicated from the Physical Institute at Halle.)—A series of experiments carried out upon various gases and vapours in a magnetic field varying from 4,000 to 20,000 units. The following substances were used at various reduced pressures—hydrogen, argon, helium, nitrogen, the halogens, the oxides of sulphur and carbon, cyanogen, methane, and silicon tetrafluoride. In general the spectra suffered a considerable change in intensity due to increase in their resistance to the electric discharge. Knockendöppel's formulæ were found to hold good except in the case of iodine and cyanogen. The Zeeman effect was found to be very difficult of observation except in the case of helium and mercury vapour.
E. C. C. B.

60. *Invisible Fluorescence.* **H. Dufour.** (Archives des Sciences, 13. pp. 537–548, June, 1902.)—Experiments were made on chlorides of barium and of radium of activity 240 and 1,000 respectively. These specimens were in sealed glass tubes, and it was found that the tubes had only a feeble action in discharging an electroscope. The radiations emitted by the glass tube under the action of the chloride of radium or transmitted by it act on the air and cause it to become radio-active. Air was caused to circulate and become exposed to the action of the radiations from the tube: this air had no action on a photographic plate when there was no radio-active tube on its path. The rectilinear direction of the radiation has been proved. Experiments were carried out on the emission and transmission of the radiations from bodies illuminated by radio-active substances. These experiments appear to show that glass has an invisible fluorescence which acts on a sensitive plate, this action being especially sensible, as in the case of visible fluorescence, at the points where the glass is roughened, as at the edges; the glass transforms the radiations which penetrate it and yields an invisible excitement over all its mass. Aluminium is especially transparent towards the radiations. It, however, also transforms them partially. There is an invisible fluorescence which is combined with a relative transparency under the action of the radiations, equally invisible, of radio-active substances. The relative opacity of aluminium for the radiations given out by glass has been confirmed by many experiments in which aluminium and glass were superposed. The emission of radiations from glass, invisible fluorescence, combines with the absorption that this substance exercises even in moderate thickness on the direct radiations from the chlorides of radium and of barium, and sometimes gives results which appear at first inexplicable. A plate of quartz with parallel faces was found to be remarkably opaque for the radiation emanating from a radio-active tube of glass covered with paper. Invisible fluorescence is very strong in the case of fluor spar. It is easily shown in the case of ordinary glass, and is very strong for Faraday's heavy glass; it is moderately

strong for didymium glass and for Iceland spar, while less pronounced in the case of uranium glass. The invisible fluorescence is stopped if on the path of the radiations a sheet of glass is placed, as this substance produces an energetic transformation of the radiations which penetrate it. J. J. S.

61. *Luminescence at Low Temperatures.* **J. Precht.** (Phys. Zeitschr. 3. pp. 457–459, July 15, 1902.)—The author has studied the luminescence of uranium nitrate crystals at low temperatures and finds that we have here to do with two separate phenomena, viz., phosphorescence (shown feebly by the crystals even at the ordinary temperature) and triboluminescence due to the shattering of the crystals through changes of density: the triboluminescence may be eliminated by finely powdering the substance. If we cool down the powder by means of liquid air we find that the phosphorescence increases till it reaches a maximum, and if we keep the temperature constant at this point the luminescence may be continued indefinitely. On cooling by means of liquid air to a still lower temperature, —193°, the luminescence ceases completely but is renewed again when the temperature rises. The maximum triboluminescence appears to occur at the same temperature as the maximum phosphorescence. Uranium sulphate and uranyl fluoride behave like uranium nitrate. Ice is triboluminescent as can very well be shown by cooling it in a Dewar vacuum glass. Quartz shows no luminescence when cooled with liquid air but then gives out light on rubbing. Barium platinocyanide, calcium platinocyanide, and pentadecylparatolylketone are substances which do not phosphoresce at the ordinary temperature but luminesce brightly on cooling strongly: all three substances are excitable by kathode rays, the double cyanides also by Röntgen rays; the ketone shows triboluminescence. The author has examined the electrical changes which occur during cooling and reheating by connecting the substances during change of temperature with an electroscope. It appears that with certain substances the appearance of active triboluminescence is associated with sudden electrical changes.

D. H. J.

62. *Black Light and Actino-electric Phenomena.* **G. le Bon.** (Comptes Rendus, 135. pp. 35–36, July 7, 1902.)—The author refers to the work of Nodon [see Abstract No. 2044 (1902)] in which the action of light in making radio-active the non-illuminated side of a thin metal plate, is considered. He points out that he had exhibited the same results five years earlier, giving to the radiation produced the name of "black light" [see Comptes Rendus, March, 1897, p. 755]. J. W. P.

63. *Radio-activity of Uranium.* **F. Soddy.** (Chem. Soc., Journ. 81. and 82. pp. 860–865, July, 1902.)—Referring to Crookes' discovery that by a chemical operation a non-uranium residue could be separated from uranium, leaving the latter without radio-activity, whilst the whole of the activity was concentrated in the residue, to which the name Ur X was given: the author describes his repetition of this separation, and his testing the radio-activity of the products got. The method of investigation employed was that of the electrometer as used by Rutherford for thorium salts, and tested thus the residue Ur X was almost inactive, whilst the uranium portion possessed normal activity. Rutherford showed that uranium radiation consists of two different types, α and β [see Abstract No. 631 (1900)]; the former being readily absorbed even by gases, whilst the latter is very penetrating and is but little absorbed by gases. The latter portion, the β-radiation, constitutes

only a slight proportion of the total radiation from uranium, and the electrometer method records only a fraction of the intensity of β-radiation, for this method depends on the ionisation of the air, and this is proportional to the absorption of the rays by the air. Thus the electrometer method practically measures only the α-radiation of uranium. On the other hand, the photographic method employed by Crookes, in which the rays are made to pass through glass or card before reaching the sensitive film, measures only the β-radiation. Hence the results obtained would be explained if the methods employed separated the β-radiation only, and left the α-radiation intact. It would appear that the methods of chemical separation employed by Crookes effect a separation only of the constituent responsible for the β-radiation. On testing the effect of the α-radiation on a photographic plate it was found to be negligible compared with that of the β-radiation. The question discussed for thorium [see Abstract No. 1068 (1902)] arises in connection with the non-separable activity of uranium : (1) Is this residual activity to be regarded as a secondary radiation produced by the presence of Ur X ? or (2) is it caused by a distinct material substance capable of chemical separation ? Experiment appears to indicate a negative answer to the first question. If a second distinct type of matter is concerned in the production of the α-radiation—if the hypothesis suggested in question (2) is correct—all attempts to separate such a constituent from uranium have hitherto failed. It is, however, interesting to note that polonium, discovered by Curie, fulfils in almost all respects the functions of this hypothetical constituent. J. J. S.

64. *Penetrating Rays from Radio-active Substances.* **E. Rutherford.** (Nature, 66. pp. 318–319, July 31, 1902.)—The author discusses the character of the rays given out by radio-active substances. Some of these possess extraordinary penetrating power. The penetrating rays from radium, compared with the deviable rays of uranium, pass through a thickness of glass about 160 times greater for the same reduction of intensity. It is suggested as possible that these rays are made up of electrons projected with a speed equal to the velocity of light. J. J. S.

65. *Perspective in Röntgen-ray Representation.* **W. Cotton.** (Röntgen Ray, Archives, 7. pp. 25–34, July, 1902.)—This is a discussion of stereoscopic and pseudoscopic relief in ordinary photography and in Röntgen-ray work, and how to disentangle the confusion that is apt to arise in the interpretation of skiagrams. The projection in a skiagram is not orthographic, but radiographic, under rays not parallel but from a source. Prints from radiographic negatives are apt to mislead unless made transparent and looked at through the back. A. D.

66. *Precautions in Radiography.* **Infroit** and **Gaiffe.** (Comptes Rendus, 134. pp. 1571–1572, June 30, 1902.)—In comparing radiographs taken with Ruhmkorff coils and those taken by static machines, the authors have found the latter always clearer. The blurring effect in the other case is traced to the action of the magnetic field of the core of the coil. The kathodic flux is deflected ; so that it is advisable, if working with the coil, to have it at such a distance from the vacuum tube, that the field is there negligible.
J. W. P.

HEAT.

67. *Liquid Thermometer for very Low Temperatures.* **R. Rothe.** (Zeitschr. Instrumentenk. 22. pp. 192–195, June, 1902. Communicated by the Physikalisch-Technische Reichsanstalt.) — "Technical" pentane, which presumably contains a small percentage of unsaturated hydrocarbons, remains quite liquid and clear, without irregularity of its capillary meniscus or precipitation of solid conglomerates, even when kept long enough at the temperature of boiling air. It may thus be used in a low-temperature thermometer, though, as the liquid becomes viscous with lowered temperature, the cooling must be carried out with sufficient slowness and extended first to the bulb and then to the capillary bore. The boiling-point of the liquid lies between 25° and 33°, and its dilatability between —187° and 0° is given by $V_t/V_0 = 1 + 0{\cdot}00139t + 0{\cdot}00000133t^2$. *Pure* pentane cannot be so used.

R. E. B.

68. *Expansion of Solids at Low Temperatures.* **J. Dewar.** (Roy. Soc., Proc. 70. pp. 237–246, July 8, 1902.)—The densities of twenty-seven solid substances (including H_2O, CO_2, Hg, and twelve hydrated salts) at about —189° C. were determined by weighings in liquid air; and by comparisons of these with the densities at 0°, —78°, and —38·85° respectively for H_2O, CO_2, and Hg, and at 17° for the other substances, the mean cubical expansibilities within the respective ranges were calculated. These are 0·00007978 [wrongly calculated in the paper, for the formula given, as 0·00008099] for ice, 0·0005704 for CO_2, 0·0000887 for Hg, and for the other substances between 0·0000365 (for chrome alum) and 0·0003567 (for paraffin); and comparisons are drawn between them and the expansibilities at higher temperatures. In the case of ice the highest density (at —273°) under atmospheric pressure would seem to be 0·9364 [corrected], which is still much less than the lowest density of water under this pressure, viz., 0·9586 (*i.e.*, at 100°), so that the volume of ice at absolute zero is not the minimum volume of the water molecules. The density of the liquid air used varied from 0·9347 to 1·0405, as areometrically determined by comparison with liquid oxygen, the density of which was taken to be 1·137. R. E. B.

69. *Dilatation-Formula for Liquids.* **E. Mallet** and **L. Friderich.** (Archives des Sciences, 14. pp. 50–58, July, 1902.)—The formula $v = c - d \log (A - t)$, where v is the volume at temperature t, and c, d, A are constants, is here tested for twenty-five normal liquids between 0° and their critical temperature t_c, and is shown to represent with sufficient accuracy the experimental results of Young and others. The formula was first suggested by Avenarius, but with $A = t_c$; but in all the cases examined the calculated best values for A are slightly in excess of t_c. The ratio c/d for all the liquids varies but little from 3·78, if the logarithms are common. R. E. B.

70. *Melting-point of Chromium.* **E. A. Lewis.** (Chem. News, 86. p. 13, July 11, 1902.)—As this number has not been ascertained accurately, the author has redetermined it by a Chatelier pyrometer in a chromium of 99 per cent. and free from carbon, made by the Goldschmidt process by reduction of

chromic oxide with powdered aluminium. The metal was melted in a lime crucible by an oxy-coal gas flame. It is very difficult to avoid breaking the platinum-iridium junction. Two experiments gave the melting-point as 1,510° and 1,520°. The pyrometer was standardised by the boiling-point of water and the melting-points of Zn (419°), Al (657°), and copper (1,065°).

S. R.

71. *Mixtures with Maximum or Minimum Vapour-Pressure.* **J. P. Kuenen** and **W. G. Robson.** (Phil. Mag. 4. pp. 116–132, July, 1902.)—The authors have carried out further experiments [see Abstract No. 1146 (1901)] on mixtures with maximum or minimum vapour pressures at a given temperature and a corresponding minimum or maximum in their critical temperatures. Three combinations were examined. With propyl alcohol and water it was found that the maximum vapour pressure remains up to the critical point and that the critical temperatures have probably no minimum. It would follow that the maximum vapour pressure in this case is not due to a small attraction between the two kinds of molecules, but to association of molecules. Theory would require that all mixtures between propyl alcohol and the maximum mixture should show retrograde condensation of the second kind. The observations made tended towards confirmation of this, though complete proof could not be obtained. With acetone and chloroform it was found that the maximum vapour pressure, which exists at low temperatures, has disappeared at the critical point, and that there is no maximum critical temperature, the critical curve connecting the two critical points in the normal manner with a slight convexity towards the high pressures. The conclusion is drawn that the low vapour pressures at low temperatures are due to an abnormal increase in the mutual attraction of the two substances at lower temperatures, and therefore probably to mutual association of the two kinds of molecules. With carbon dioxide and ethane at low temperatures, it was found that the maximum vapour pressure was not due to a separation into two liquids, no such thing occurring up to the region where solidification commences. In agreement with theory the maximum vapour pressure at low temperatures belongs to the 45 per cent. mixture, as does the minimum critical temperature. Pressure-temperature and volume-composition diagrams are given, and it is shown how along the three-phase curve, the composition diagrams are given, and it is shown how, along the three-phase curve the composition of the vapour phase may be deduced from the pressures and how the heat of transformation may be determined. W. E. T.

72. *Correction of the Boiling-points of Liquids from Observed to Normal Pressure.* **S. Young.** (Chem. Soc., Journ. 81. and 82. pp. 777–783, June, 1902.)—The author in 1885, in conjunction with Ramsay, showed that the values of $dt/dp \cdot \frac{1}{T}$ (where dt/dp is the rate of increase of vapour pressure per unit rise of temperature, and T is the absolute temperature) are nearly the same (C) for different substances when these are compared at the same pressure. Although the variations from constancy are real, Crafts was then able to give a convenient table for the correction of boiling-points. This table contains some misprints, and is less extensive than it may now be made. The author therefore gives the following revised table. To correct a boiling-point from observed to normal pressure, Δ_t is to be added, where—

$$\Delta_t = (760 - p)\,(273 + t)\,C.$$

The value of C for the most closely related substance is taken from the table;

p is the observed pressure, and t the observed, or better, roughly corrected boiling-point.

VALUES OF $C = \frac{dt}{dp} \cdot \frac{1}{T}$ AT 760 mm.

Name of Substance.	Boiling-point (abs. temp.).	dp/dt	C.
Oxygen	90·3°	75·9	0·000146
Nitrogen	77·5	89·0	0·000145
Argon	86·9	83·2	0·000138
Krypton	121·3	61·8	0·000133
Xenon	163·9	45·9	0·000133
Chlorine	239·4	33·2	0·000126
Bromine	331·75	25·2	0·000120
Iodine	458·3	18·75	0·000116
Mercury	629·8	13·4	0·000118
Sulphur	721·4	12·2	0·000114
Carbon monoxide	83·0	81·3	0·000148
Sulphur dioxide	262·9	33·7	0·000113
Ammonia	240·1	37·7	0·000110
Carbon disulphide	319·25	24·7	0·000127
Boron trichloride	291·25	26·8	0·000128
Phosphorus trichloride	346·85	23·45	0·000123
Silicon tetrachloride	329·9	24·0	0·000126
Stannic chloride	387·1	21·4	0·000121
Methyl chloride	249·35	31·9	0·000126
Chloroform	333·2	25·2	0·000119
Carbon tetrachloride	349·75	23·25	0·000123
Methane	109·0	68·2	0·000135
n-Pentane	309·3	25·8	0·000125
n-Hexane	341·95	23·9	0·000122
n-Heptane	371·4	22·3	0·000121
n-Octane	398·8	21·1	0·000119
*iso*Pentane	300·95	26·2	0·000127
Di*iso*propyl	331·1	24·3	0·000124
Di*iso*butyl	382·1	20·9	0·000125
*cyclo*Hexane	353·9	22·7	0·000124
Benzene	353·2	23·3	0·000122
Toluene	383·7	21·8	0·000120
Naphthalene	491	17·1	0·000119
Anthracene	616	15·0	0·000108
m-Xylene	412	21·1	0·000115
Diphenylmethane	538	15·1	0·000123
Triphenylmethane	626	14·8	0·000108
Fluorobenzene	358·2	23·3	0·000120
Chlorobenzene	405·0	20·5	0·000120
Bromobenzene	429·0	19·3	0·000120
Iodobenzene	461·45	18·0	0·000120
Bromonaphthalene	553·45	15·75	0·000115
Ethylene dibromide	405	20·8	0·000119
Methyl ether	249·4	32·0	0·000125
Ethyl ether	307·6	26·9	0·000121
Acetone	330	26·4	0·000115
Benzophenone	578·8	15·8	0·000109
Dibenzylketone	603·55	15·2	0·000109
Anthraquinone	650	13·6	0·000113
Aniline	457·4	19·6	0·000112
Quinoline	510·5	17·9	0·000115

VALUES OF $C = \frac{dt}{dp} \cdot \frac{1}{T}$ AT 760 mm. (*continued*).

Name of Substance.	Boiling-point (abs. temp.).	*dp/dt*	C.
Methyl formate	304·9	28·8	0·000114
Ethyl formate	327·3	26·6	0·000115
Methyl acetate	330·1	26·8	0·000113
Propyl formate	353·9	24·5	0·000115
Ethyl acetate	350·15	25·1	0·000114
Methyl propionate	352·7	24·9	0·000114
*iso*Butyl formate	370·85	23·45	0·000115
Propyl acetate	374·55	23·5	0·000114
Ethyl propionate	372·0	23·7	0·000113
Methyl butyrate	375·75	23·3	0·000114
Methyl *iso*butyrate	365·3	23·8	0·000115
Amyl formate	396·25	21·8	0·000115
*iso*Butyl acetate	389·2	22·5	0·000114
Propyl propionate	395·15	22·3	0·000114
Ethyl butyrate	392·9	22·3	0·000114
Ethyl *iso*butyrate	383·1	22·5	0·000116
Methyl valerate	389·7	22·4	0·000114
*iso*Butyl propionate	409·8	21·4	0·000114
Propyl butyrate	415·7	20·9	0·000115
Propyl *iso*butyrate	406·9	21·8	0·000113
*iso*Propyl *iso*butyrate	393·75	22·0	0·000115
Ethyl valerate	407·3	21·4	0·000115
Amyl propionate	433·2	20·4	0·000113
*iso*Butyl butyrate	429·9	20·5	0·000113
*iso*Butyl *iso*butyrate	419·6	20·6	0·000116
Propyl valerate	428·9	20·5	0·000114
Amyl butyrate	451·6	19·5	0·000113
Amyl *iso*butyrate	441·8	19·6	0·000115
*iso*Butyl valerate	441·7	19·9	0·000114
Methyl alcohol	337·9	29·6	0·000100
Ethyl alcohol	351·3	30·35	0·000094
Propyl alcohol	370·4	28·8	0·000094
Amyl alcohol	403	25·3	0·000098
Phenol	456	20·5	0·000107
Acetic acid	391·5	23·9	0·000107
Phthalic anhydride	559	16·0	0·000112
Sulphobenzide	652	15·2	0·000101
Water	373·0	27·2	0·000099

D. H. J.

73. *Vapour Pressures and Specific Volumes of Isopropyl Isobutyrate.* **S. Young** and **E. C. Fortey.** (Chem. Soc., Journ. 81. and 82. pp. 783–786, June, 1902.)—In attempting to prepare di-isopropyl by the electrolysis of potassium isobutyrate, it was found that there was a considerable quantity of isopropyl isobutyrate formed, though the yield of the di-isopropyl was small. The opportunity was taken to determine the vapour pressures and specific volumes of the ether; it was not found possible to ascertain the critical data on account of the marked decomposition of the substance at temperatures above 230°. The ether boils at 120°·75 at normal pressure; the sp. gr. 0°/4° is 0·86867. D. H. J.

74. *Influence of Temperature on Association and on Molecular Elevation of the Boiling-point.* **W. R. Innes.** (Chem. Soc., Journ. 81. and 82. pp. 682–706, June, 1902.)—Using a modified Beckmann apparatus, the author determined the molecular rise of boiling-point for benzene solutions of phenanthrene, benzophenone and benzil at different pressures (corresponding to different boiling-points of the benzene). The molecular rise of boiling-point was also calculated, A, from the heat of vaporisation; B, from the rate of change of vapour pressure with temperature. The calculated and the mean experimental values for concentrations up to 6/100 gram-molecule per 100 gm. benzene, are given in the following table:—

	Temps. in Ebullition					
	54°	58°	63°	73°	80°	93°
Calculated A	21·6	22·2	23·0	25·0	26·5	29·5
„ B	21·05	21·6	22·4	24·25	25·5	27·8
Phenanthrene ...	21·0	—	22·4	23·55	25·25	27·3
Benzophenone ...	20·17	—	21·6	23·0	23·8	26·2
Benzil	—	21·0	—	—	23·3	26·24

Series of similar determinations were made with the abnormal substances benzoic acid, o-brom-benzoic acid, β-benzil monoxime and dimethyl tartrate. It was found that the dissociation of the complex molecules increased with the temperature between 54° and 80° in every case. Between 80° and 93° there was an apparent decrease of dissociation at all concentrations with benzoic acid and β-benzil monoxime; o-bromobenzoic acid and dimethyl tartrate were more dissociated at 93° in dilute solutions, but in more concentrated solutions the molecular weights became equal to those at 80° with the former substance and greater with the latter. The heats of dissociation of β-benzil monoxime, o-bromobenzoic acid, and benzoic acid were calculated from the molecular weights at different temperatures and found to be of the same order of magnitude as those of a number of typical dissociating gases.

D. H. J.

75. *Curve of Boiling-points of the System: Hydrazine + Water.* **L. de Bruyn** and **J. W. Dito.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 155–159, June 28, 1902.)—J. W. Dito's previous researches [see Abstract No. 2111 (1902)] having shown that the maximum density of the system hydrazine + water corresponds fairly well with the composition $N_2H_4 . H_2O$, the authors now go on to investigate the curve of the boiling-points of the same system, the main result being that there exists no chemical compound $N_2H_4 . H_2O$ with a constant boiling-point of 120°, as hitherto supposed. The figures given in the original paper show that a liquid boiling at 119°·8, and of the approximate composition 50 mol. N_2H_4 + 50 mol. H_2O, will give off a vapour containing 42 mol. N_2H_4 and 58 mol. H_2O, whereas a vapour of the composition $N_2H_4 . H_2O$, is given off at 120°·4 by a liquid containing 54 mol. N_2H_4 and 46 mol. H_2O. The curve shows that a maximum boiling-point of 120°·5 corresponds with a liquid holding 58 mol. N_2H_4. Researches in the viscosity of the same system are being carried on by one of the authors, and experiments on the electric conductivity have been commenced with the assistance of Prof. E. Cohen. A. G.

76. *Volatilisation and Recrystallisation of the Platinum Metals.* **L. Holborn** and **F. Henning.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 39. pp. 936–943, July 31, 1902. Communicated by the Physikalisch-Technische Reichsanstalt.)—The thermo-electric values of two Pt | PtIr thermal-couples were found to decrease by 6 and 14 per cent. after 8 hours at a white heat, whilst that of a Pt | PtRh couple increased by only ¼ per cent. This is probably due to volatilisation of the iridium. Under similar conditions iridium lost 70 mg., platinum 7 mg. and rhodium 6 mg.; an alloy of 90Pt 10Ir lost 24 mg., an alloy of 90Pt 10Rh lost only 9 mg. The melting-point of iridium is given at 2,050°—500 degrees higher than that of platinum. The heated strips of metal exhibit a very distinct structure, the surface consisting of uniform patches (often hexagonal) separated by an interlacing network. The alloy 90Pt 10Rh resembles the pure metals, but in the alloy 90Pt 10Ir the separate crystals are very much larger, and the network is coarser. A similar crystalline structure was developed in silver and gold by heating for some hours at a temperature 100° below the melting-point. The structure, which was usually rendered more clearly visible by etching with aqua-regia, was not present in any of the metallic strips previous to the heating. T. M. L.

77. *Supercooling and Crystallisation of Polymorphic Substances.* **K. Schaum** and **F. Schoenbeck.** (Ann. d. Physik, 8. 3. pp. 652–662, June, 1902.)—Experiments were made on benzophenone. Small samples (0·5 c.c.) were sealed up in glass tubes and subjected to various heatings, coolings, &c. Supercooling was favoured (*a*) *very considerably* by heating to a high temperature, (*b*) *considerably* by prolonged heating, (*c*) *to a small degree* by repeated melting, (*d*) *markedly* by admixture with other substances (alcohol).

The effects (*a*)–(*c*) are regarded as due to two causes: (1) A removal or rendering innocuous of the *critical spots* in the interface between the melted substance and the glass; (2) A change in the properties of the melted benzophenone tending to favour supercooling. In the second portion of the paper very remarkable observations made with the metastable (monoclinic) form of benzophone are described. This form could be obtained in states possessing varying degrees of stability. The influences (*a*)–(*d*) enumerated above, especially (*d*), are found to increase the stability of the metastable form. The higher the temperature to which the melt is brought, the more easily is the metastable form obtained and the greater is the degree of stability it exhibits. The metastable form, if possessing a high degree of stability, gave a melt from which the metastable form separated, whereas if it was first transformed into the stable variety, then the latter always separated. These phenomena lead the authors to conclude that *the melts derived from the metastable and stable forms of benzophenone are different.* F. G. D.

78. *Heat of Solution at Saturation-point.* **E. v. Stackelberg.** (Zeitschr. Phys. Chem. 41. pp. 96–100, June, 1902.)—Holsboer concluded [see Abstract No. 1329 (1902)] that the method of von Roozeboom and von Deventer for determining the "theoretical heat of solution" was preferable to that of von Stackelberg. The latter considers this conclusion invalid. Both Holsboer and himself had used the only correct method for soluble substances, viz., by proceeding from concentrated solutions, determining the heat of dilution and only making measurements of heat of solution for very dilute solutions; and he claims that Holsboer's work in no way decides between Roozeboom's tangent construction and his own graphical extrapolation, or whether, in cases where the heat of dilution leads to small temperature changes, the experimental determination of the total heat of solution is to be preferred to the successive solution of the solid. W. E. T.

SOUND.

79. *Vibrations of a Telephone-membrane.* **R. Kempf-Hartmann.** (Ann. d. Physik, 8. 3. pp. 481–538, June, 1902.)—A telephone receiver is vibrated by a special sustained sound, say by singing a vowel into the telephone transmitter; then a spot of light is cast on a mirror fixed on the receiver-membrane and thence to moving photographic film. From the wave records, thus produced, the author obtains a set of curves representing vowels, diphthongs, and consonants, also reproductions corresponding to other sound sources, *e.g.*, the Duddell singing-arc. Some results obtained are: (1) the telephone membrane produces the wave-impulses without much momentum, the time taken by it to fall into accord with the forced impulses being in some cases only about 1000th of a second; (2) the maximum amplitude becomes constant after two periods from the start, and the form of the curve thereafter becomes constant; (3) the form of curve depends on the period of the sound; (4) a rubber damper placed near the centre of the diaphragm changes the character of the sound; (5) a magnetic relay used was found not sensitive enough to be of service. P. E. S.

80. *Centre of Gravity of Binary Concords.* **A. Guillemin.** (Comptes Rendus, 134. pp. 1579–1582, June 30, 1902.)—The dissonance of two notes depends on several independent variables, viz.: (1) The numbers *m*, *n* of the frequencies of the notes; (2) the height H of the concord $\frac{P}{Q} \gtrless \frac{m}{n}$; (3) the degree of falseness (in millisavarts) of this concord. Calling this last *a*, the author states the following laws: (1) If *a*, *m*, and *n* remain constant, the number of beats per sec. B varies proportionally to the height of the concord. (2) If the height H, and *m* and *n* remain constant, B varies proportionally to *a*. Some further properties of these quantities are shown. J. W. P.

81. *Binary Concords.* **A. Guillemin.** (Comptes Rendus, 135. pp. 98–101, July, 15, 1902.)—Taking a binary concord whose constituents have the frequencies *m* and *n*, the author calls the intermediate note of frequency *h* given by the relation $\frac{1}{h}=\frac{1}{2}\left(\frac{1}{m}+\frac{1}{n}\right)$, the centre of gravity of the concord. Various properties of this centre of gravity are shown by a diagram and by consideration of the usual concords. J. W. P.

82. *Coast Fog-signals.* **N. G. Gedye.** (Engineer, 94. pp. 18–19, July 4, 69–70, July 18, and pp. 95–96, July 25, 1902. Paper read before the Civil and Mechanical Engineers' Society, March, 1902.)—The author first considers the phenomena of fog and the conditions affecting the transmission of sound-signals at sea. Different methods of signalling are then considered, viz., subaqueous signalling, bells and gongs, explosive signals, whistles, reed horns, sirens with trumpets. Drawings and descriptions of the various instruments are given along with experimental data collected from various parts of the world. A summary of the investigations of the committee of the Trinity House (1901) is given. J. W. P.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

83. *Open Currents.* **V. Crémieu.** (Comptes Rendus, 135. pp. 27–30, July 7, 1902.)—In view of H. Pender's criticism [see Abstract No. 2140 (1901)] fresh experiments were made. Again the deviations observed do not seem due to magnetic effect of electric convection. [See Abstracts Nos. 144, 858, 1100, 2139, 1916 (1901); 55, 56, 482 (1902).] A. D.

DISCHARGE AND OSCILLATIONS.

84. *Radiation from Points of rapidly alternating Currents of High Potential.* **A. Möhlmann.** (Ann. d. Physik, 8. 4. pp. 768–786, July, 1902. From the author's Inaugural Dissertation.)—Himstedt has already shown [see Abstract No. 1708 (1899)] that a plate held near a point attached to one pole of a Tesla coil becomes charged positively, negatively, or not at all, according to the distance between the point and the plate; commutation of the primary current or interchange of the poles is without influence on the production of the discharge. The author finds that similar results may be obtained when an ordinary induction-coil is used; at a certain distance the plate becomes always positively charged, at a greater distance negatively: there is a neutral point between these two positions of the plate. The position of the neutral point is dependent on the potential of the pole of the coil, but independent of the frequency of the current. D. H. J.

85. *Emanation from Phosphorus.* **G. C. Schmidt.** (Phys. Zeitschr. 3. pp. 475–481, July 15, 1902.)—Air in contact with phosphorus becomes a conductor, and the author sought to attribute the conductivity to the presence of positive oxygen atoms derived from oxygen molecules; the negative oxygen atom, according to this idea, serves for the oxidation of the phosphorus. Experiment showed, on the contrary, that the conductivity is a convection phenomenon and is due to the carriage of electricity by the particles of vaporised phosphorus, phosphorus pentoxide, &c. The movements of the oxidation cloud can be traced by the help of the accompanying phosphorescence, and it was found, for instance, that when this cloud was brushed away by a suitable current of air, the conductivity ceased; similarly the intervention of glass-wool or other substance which arrests solid particles was sufficient to prevent conductivity. The experiments were conducted as follows: A suitable closed glass vessel was provided with two small, flat, metal plates, suspended horizontally near one another so that a piece of phosphorus could be made to rest on the lower plate; this lower plate was connected with one pole of a battery, while the upper plate was joined up with a quadrant electrometer: the deviations of the electrometer needle gave a measure of the electricity which passed in a given time between the metal plates. D. H. J.

86. *Electrical Conductivity of Gases containing Vapours of Fuming Sulphuric and Fuming Nitric Acid.* **K. v. Wesendonck.** (Phys. Zeitschr. 3. pp. 459–

461, July 15, 1902.)—The author in an investigation on the effect of fuming liquids on the electrical activity of furnace gases, found a remarkable difference in the behaviour of vapours from fuming sulphuric and nitric acids respectively. When the furnace gases were led through the acids so as to form a thick mist, the conductivity of the gases was almost destroyed; the effect was most marked in the case of the vapour from the fuming sulphuric; if the furnace gases before coming in contact with the fuming nitric acid were bubbled through pure ordinary sulphuric acid, a mist no longer appeared, and the conductivity of the gases was, to a large extent, unimpaired. From these and other similar experiments, it would appear that the electrical phenomena observed are dependent on the presence or absence of non-gaseous particles (small particles of SO_3, moisture, &c.). An optical examination of the impregnated furnace gases by the methods employed by Kiessling (Die Dämmerungserscheinungen, Leip. Voss, 1885 and 1888), confirms this conclusion. D. H. J.

87. *Ionisation by Collision.* **J. Stark.** (Ann. d. Physik, 8. 4. pp. 815-828, July, 1902.)—The author applies the theory of his previous paper [see Abstract No. 1378 (1902)], to a discussion of the recent experiments on ionisation of Townsend [see Abstract No. 1351 (1902)], Lenard, Kreusler, Schweidler, McClelland [see Abstract No. 1090 (1902)], and Kirby [see Abstract No. 1347 (1902)]. In particular he traces the connection between the potential difference of the electrodes and the strength of the current passing through a gas ionised by an independent source, showing why at first the current is nearly proportional to the potential difference, then becomes constant, and finally increases again with the potential difference owing to the additional ionisation due to the collision of ions. W. E. T.

88. *Action of Different Regions of the Spectrum upon Matter.* **G. le Bon.** (Comptes Rendus, 135. pp. 32-35, July 7, 1902.)—The bodies experimented on were arranged as plates inclined at 45°, at a certain distance above the plate of an electroscope. Light is allowed to strike the plate, and the discharging action upon the electroscope is studied. The luminous sources employed were the sun, and the sparks of a condenser with aluminium electrodes. To separate the different regions of the spectrum and to determine the action of each, screens of various substances (quartz, glass, &c.) were placed between the source and the body on which the light was to fall. The rate of discharge of the electroscope measures the activity of the particular radiation operating at the moment. For sunlight, the effect upon tin, copper, and zinc plates (all amalgamated) being taken at 1,000, the effects upon aluminium, magnesium, zinc, lead lie between 1,000 and 40, and the effects on gold, cobalt, wood, &c., are about 1. The distribution of this activity in the different regions of the spectrum for a given metal is also considered, and the general connection of the phenomena with radio-activity is pointed out. J. W. P.

89. *Back-E.M.F. in Electric Arcs.* **W. Mitkiewicz.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 5b. pp. 228-229, 1902.)—After maintaining that the numerous attempts made to show the existence of a back-e.m.f. in electric arcs have all failed to give reliable results, the author goes on to examine more closely what happens immediately after breaking the circuit. In Blondel's experiments the current feeding the arc was broken periodically by means of a special rotating commutator. As the main circuit was broken, this commutator would immediately connect the circuit of a galvanometer with the

electrodes of the arc, the time separating the breaking of the main from the closing of the galvanometer circuit being about 1/600 sec. As Blondel observed no back-e.m.f. force at all, the author tests the phenomena occurring during the interval of 1/600 sec. elapsing between the breaking of the circuit and the moment of observation, by investigating the curve of p.d. between the electrodes of an arc fed by an intermittent current of constant direction. This curve is found to be quite similar to that representing the e.m.f. at the terminals of a non-inductive resistance inserted in the circuit. As, however, no absolutely instantaneous break was obtained, the interval being of the order of 0·0001 sec., the author considers that his negative results afford no evidence of the non-existence of a back-e.m.f. In accordance with Duddell's views, it is suggested that this force might be the difference of two thermic e.m.f.'s produced at the contacts of the incandescent gaseous medium with the ends of the electrodes, the higher e.m.f. corresponding to the hotter electrode. It is inferred that the slight difference of temperatures is compensated in an interval less than 0·0001 sec., the e.m.f. of the thermo-element *carbon-gas-carbon* thus falling down to zero. [See also Abstract No. 1540 (1902).] A. G.

90. *Using an Aluminium Condenser to Produce "Singing" Arcs.* **W. Mitkiewicz.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 5b. pp. 229–238, 1902.)—The author suggests replacing the ordinary high-capacity condensers necessary to produce Duddell's "singing arc" by the much less costly aluminium condenser, made up of an aluminium electrode connected with the positive pole immersed in a 7 — 8 per cent. sodium bicarbonate solution, and thereby becoming coated with a thin layer of oxide or hydroxide. Two plates of sheet iron of the same dimensions are placed upon the faces of the condenser, from which they are separated by means of thin caoutchouc so that the distance between the aluminium and each of the iron plates does not exceed 3 mm. The whole system is provided with caoutchouc rings, and placed in the vessel containing the solution. The iron plates are, of course, connected with one another by means of a metal wire. The capacity of such a condenser with a working surface of about 5 sq. dm. was of the order of 100 microfarads. The magnitude of this capacity is due to the extreme thinness of the insulating layer. In order to produce with this device the phenomenon known as a "singing arc," Duddell's arrangement is made use of. After each experiment the electrodes must be taken out of the solution and carefully dried. This condenser may be advantageously used for many other experiments as well, *e.g.*, for all "speaking" arc devices. Full particulars are given of the apparatus employed. A. G.

91. *The Arc Spectrum with Heavy Currents.* **W. B. Huff.** (Astrophys. Journ. 16. pp. 27–30, July, 1902.)—Direct currents varying from 2 to 250 amperes were made use of, and photographs taken of the spectra of the arc with different metal poles. The exposures for the two extreme currents in a given case were made on the same plate, so that comparison could be easily made. Metals of low melting-points, such as lead, zinc, and cadmium, showed fairly definite absorption spectra. With calcium the H and K lines were easily reversed and showed the "density shift." Iron did not give any definite results. With carbon poles it was noticed that with increasing currents the "carbon" spectrum increases in velocity far faster than the "cyanogen" spectrum. The structure of the arc was examined with a flat grating and with carbon poles containing metallic impurities; the lines due to the latter are seen only in the close neighbourhood of the negative pole, while the carbon and cyanogen bands have their origin at the positive pole. The author concludes from his observations that the cyanogen spectrum is produced in the outer sheath of the arc. E. C. C. B.

92. *Discharge of Positive Electrification by Hot Metals.* **R. J. Strutt.** (Phil. Mag. 4. pp. 98–103, July, 1902.)—Guthrie has shown that red-hot metals are able to discharge positive electricity; the present paper seeks to determine when this discharge becomes sensible. The detector is a special form of electroscope as used by C. T. R. Wilson. The charged body is a wire which discharges its electricity, when heated, to the interior silvered surface of an enclosing tube, the wire and tube being heated in an oven. It is found that the leak is sensible at much lower temperatures than it was previously believed to be, viz., about 270° C., and that it increases very rapidly with the temperature. The point at which the effect becomes noticeable does not appear to depend very largely on the nature of the metallic surface or on the surrounding gas, but it alters nearly as much from slight changes in the condition of the surface of the metal, produced by continued heating, as it does when an entirely different metal is substituted.

R. S. W.

93. *Effect of Self-Induction of a Coil in the Ultra-Violet Part of the Spark Spectrum.* **E. Néculcéa.** (Comptes Rendus, 135. pp. 25–27, July 7, 1902.) —This is a continuation of the work referred to in Abstract No. 2247 (1902). The spectrum of tin is here examined from 2664·9 to 2118·6, and a description of the effect of the varying self-induction upon the character and behaviour of about 40 lines is given. In the region 2,700 to 2,000, and with a self-induction of order 0·04191 henrys, the spark spectrum of tin has only 14 lines, all very fine and clear. J. W. P.

94. *Lenard Rays.* **J. J. E. Durack.** (Phil. Mag. 4. pp. 29–45, July, 1902.)—The following points concerning Lenard rays are investigated experimentally and then compared with recent theory: (1) The velocity of the rays as the pressure in the tube alters; (2) the variation of the ionisation produced outside the discharge-tube as the pressure in the tube alters; (3) the change in the current carried by the rays under the same circumstances; (4) the ionising power of the rays, *i.e.*, the number of ions one Lenard ray ion produces in travelling 1 cm. through a gas at some standard pressure. To obtain the velocity, the deflection due to a magnetic field is measured. As determined in this way the velocities vary from $5 \cdot 10^9$ cm. per second for the high discharge potentials, to $3 \cdot 2 \times 10^9$ for the lower. When the rays are shot through an aluminium window into a receiving tube, the current, for different distances of the receiving plate from the window, is found to obey the inverse square law. The current carried by the Lenard rays themselves is found to increase as the pressure is lowered, it then reaches a maximum and finally decreases as the exhaustion is pushed further. It is found that the number of pairs of ions one Lenard ray ion produces in travelling 1 cm. in air at 1 mm. pressure is 0·43. Townsend has found a value fifty times greater. One important conclusion come to is that very fast moving ions are less efficient ionisers than slow ones. The radius of an ion is calculated, and is found to lie between the limits that have been assigned to it in other ways.

R. S. W.

95. *Mechanical Phenomena of the Disruptive Discharge.* **J. Semenov.** (Comptes Rendus, 135. pp. 155–158, July 21, 1902.)—The author disproves the common view that, in the disruptive discharge, material particles are torn from each pole and carried over to the other. He finds that the positive pole suffers no such dismemberment, and that the material carried by the spark to the kathode comes solely from the gas or vapour adjoining. The arrangement used consists of a tube of glass from 0·5 to 1 mm. internal diameter, filled with a saline solution and placed at the negative pole of the coil. The discharge is made to pass from a gas flame to this tube. By interchanging the poles, the contrary effect is studied and the above result arrived at. J. W. P.

96. *Electromagnetic Vibrations in Metal Tubes.* **R. H. Weber.** (Ann. d. Physik, 8. 4. pp. 721–751, July, 1902, Habilitationsschrift.)—The mathematical treatment of the propagation of electromagnetic disturbances along a cylindrical wire have recently been given by Sommerfeld [see Abstract No. 570 (1899)], and by Abraham [see Abstract No. 1460 (1900)]. If we replace the dielectric in the above cases by metal and *vice versâ*, we obtain the problem of the present article. The experimental proof that electromagnetic vibrations may occur in tubes has already been given by P. Drude [see Abstract No. 1246 (1898)], and by A. Becker [see Abstract No. 1876 (1902)]. The author first attacks the problem mathematically, commencing with Maxwell's vector equation in a form used by H. Weber. From this, the following six general equations in cylindrical co-ordinates are finally derived :—

$$E_z = ARe^{ikt + ipz + in\phi},$$

$$M_z = BRe^{ikt + ipz + in\phi},$$

$$E\phi = \frac{-1}{r(h^2\sigma^2 - p^2)}\left(AnpR + Bh\sigma^2 r\frac{dR}{dr}\right)e^{ikt + ipz + in\phi},$$

$$M\phi = \frac{-1}{r(h^2\sigma^2 - p^2)}\left(BnpR + Ahr\frac{dR}{dr}\right)e^{ikt + ipz + in\phi},$$

$$E_r = \frac{i}{r(h^2\sigma^2 - p^2)}\left(Bnh\sigma^2 R + Apr\frac{dR}{dr}\right)e^{ikt + ipz + in\phi},$$

$$M_r = \frac{i}{r(h^2\sigma^2 - p^2)}\left(AnhR + Bpr\frac{dR}{dr}\right)e^{ikt + ipz + in\phi};$$

where the E's and the M's are the electric and magnetic vectors respectively. At the cylindrical surface $r = a$, a second medium is now postulated and equations obtained for the continuity of the electric and magnetic vectors at the interface. These lead to Bessel functions, both for the interior (dielectric), and for the space beyond $r = a$ (supposed all metallic). The problem is now simplified by assuming the vibrations independent of z. Results are then obtained showing that a doubly infinite series of overtones may occur, the series, however, being inharmonic ; these solutions involve the nth Bessel function. For $n = 0$, we have the first overtone which presents axial symmetry. For $n = 1$ we have the first case in which axial symmetry is violated, and that which has already been obtained in the experiments both by P. Drude and by A. Becker. This case and that for $n = 2$ are illustrated by diagrams showing the distribution of the vectors. The paper concludes with an account of experimental work on the lines of that of A. Becker [see Abstract No. 1876 (1902)] in which the theoretical results were confirmed. E. H. B.

97. *Calculating the Capacity of Popov's Oscillator.* **M. Boulgakow.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 5b. pp. 209–223, 1902.)—With his researches in wireless telegraphy, A. S. Papov used an oscillator, consisting of a long and rather thin vertical wire. When considering the earth as a conductor, the following system is approximately realised : An extremely elongated body is placed in the neighbourhood of an infinite plane with its length vertical with respect to the latter, its surface being one of equal potential, while the plane is another surface of equal potential. The charge Q_0 of the body, corresponding to a potential V_0, the potential of the plane being zero, has to be determined. The shape of the body being undetermined, except that its length must be very great as compared with the transverse dimensions, the problem of calculating the capacity may be solved by a special method without making any other hypotheses as to the shape, this being determined by the final results. After having given the analytical expression for the potential V in a field surrounding an electrified conducting ellipsoid by means of elliptical co-ordinates, the author proceeds to solve the problem on the following fundamental principle : Supposing some electrical masses to be distributed in an arbitrary manner, calculate the potential V depending on them, for each point of the space ; construct a series of equipotential surfaces and choose out of them those surrounding the given masses ; let the masses comprised under the denomination m_1 be surrounded by the surface S_1 ; other masses, denoted by m_2, will be surrounded by the surface S_2, and so on. Let the potential corresponding to S_1 be V_1 and so on for the remaining equipotential surfaces. Suppose all the masses to be surrounded by the equipotential surface S. Then in the remaining part of the space, the potential V, continuous together with its derivatives $\partial V/\partial x$, $\partial V/\partial y$, $\partial V/\partial z$, will obey Laplace's equation, while on the surfaces S_1, S_2, S_3, it will have the values V_1, V_2, V_3, respectively. Take a series of conductors, the surfaces of which coincide with S_1, S_2, S_3 . . . Impart to them the potentials V_1, V_2, V_3 . . . respectively. The function V, as determined above, will possess all the properties, which must belong to the potential in the points of the field surrounding the given conductors with the values of the potential given to each of them. Surrounding next each of the surfaces S_n (only this, excluding the others) by a closed surface, calculate the flux. According to Gauss' theorem, this flux is represented by the product of the charge of the surface S_n by 4π. Now for the field first given, the flux is equal to the product by 4π of the sum of all the masses it contains. Hence it is inferred that the charge of each surface S_n of a conductor is equal to the sum of the auxiliary masses surrounded by the surface S_n. The author thus determines the form of the vibrator, for the capacity of which the expression $L/\left\{2\log(L/\delta\sqrt{3})\right\}$ is calculated where L denotes the length and δ a magnitude practically equivalent to the largest thickness of the body. A. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

98. *Electric Conductivity and Atomic Heat of Metals.* **F. Streintz.** (Ann. d. Physik, 8. 4. pp. 847–853, July, 1902.)—The author points out that the temperature-coefficients of the specific resistances of pure metals are, according to the most recent investigations, namely, those of Dewar and Fleming, and of Jäger and Diesselhorst, nearly all greater than 1/273, and in many cases, very considerably greater. Hence Clausius' statement that the resistance is approximately proportional to the absolute temperature ceases to have any real significance. The author shows, in fact, that the temperature coefficient possesses a specific character, increasing with increasing atomic weight of the metal. It is also pointed out that, with the exception of mercury and thallium, the temperature-coefficient of resistance is greater the lower the melting-point of the metal. The paper concludes with an endeavour to trace a connection between the above temperature-coefficient and the "ratio of the displacement of the atoms to their mutual distance apart." F. G. D.

99. *Sensibility and Inertia of Selenium Cells.* **E. Ruhmer.** (Phys. Zeitschr. 3. pp. 468–474, July 15, 1902.) — The manifold application of selenium cells within recent years has made an exact knowledge of the action of light in diminishing the resistance of these cells, a matter of importance. The author finds that two different types of cells—called by him "hard" and "soft"—can be prepared. The difference between these cells is dependent on the allotropy of selenium. A hard cell may be obtained by rapidly cooling a plate of selenium which has been bound bifilarly with copper wire. The plate is rubbed with a specimen of the black stick modification of selenium, and is agitated during cooling. The soft cell is obtained by cooling the selenium slowly; it is then heated for a time at 200°. The soft cell is coarse grained, the hard cell fine grained. These two kinds of cells behave differently; the soft cells have less resistance than the hard cells, and are more sensitive for weak, but less sensitive for strong, illumination than the latter. The author points out that the construction of a selenium cell is an important matter, and while leaving the full account of this part of the subject till later, mentions that he has, with very thin plates, made a cell which has its resistance of 900,000 ohms reduced to 69,000 ohms by exposure to an illumination of 50 candles. Light does not produce its effect instantaneously, and the effect does not disappear the moment the light is cut off; the phenomenon exhibited is called by the author inertia, and has been carefully investigated by him. On illuminating a cell the greater part of the effect is produced during the first second, but in no case examined was the action complete, even after five minutes. The further change after a few minutes' interval is greater for the hard than for the soft cells. The increase of resistance on cutting off the light is slow, and is slower for the soft than for the hard cells. A cell should be left in the dark for twenty-four hours before a determination of its sensibility is made. D. H. J.

100. *Electric Properties of Diamond.* **A. Artom.** (Accad. Sci. Torino, Atti, 37. 15a. pp. 475–485, 1901–1902.) — Specific resistance at 15° from $0{\cdot}183 \times 177{\cdot}10^{12}$ to $1{\cdot}280 \times 370{\cdot}10^{12}$ ohm. cm. (graphite 406×10^{-6} to 1835×10^{-6}). The specific resistance falls to half under Röntgen rays. Dielectric constant 9·77 to 16·74, mostly about 16, which is very high (index of refraction $= 2{\cdot}469$, and its square about 7). This tends to show that the diamond crystal has passed through the liquid state. Residual polarisation very high; electrostatic hysteresis distinct; a lamina rotates in a rotating electric field; the dissipation of energy by electrostatic hysteresis is less than in ebonite or glass. Piezoelectric phenomena only rarely, and then very feeble; pyroelectricity recognised in most instances. The diamond is feebly magnetic, and after being in a strong field it retains well-marked magnetism for a rather long time. A. D.

101. *Convenient Form of Capillary Electrometer.* **L. Houllevigue.** (Journ. de Physique, 1. pp. 382–383, June, 1902.)—An alcohol thermometer tube of

about 1·25 mm. bore is bent twice at right angles, and the two ends thus turned up are terminated by larger tubes or cups. It is filled, with the exception of a thread of mercury, of about 2 cm. length in the middle, with acidulated water. Two platinum plates, forming the electrodes, are immersed in the acidulated water in the cups. The whole is fixed to a support carrying a reading microscope, the support being hinged to a pillar, so that the inclination of the capillary tube can be controlled by a screw and spring. E. C. R.

102. *Insulation Resistance of Capillary Electrometer, and Minimum Quantity of Electricity required to produce a Visible Excursion.* **G. J. Burch.** (Roy. Soc., Proc. 70. pp. 221–226, July 8, 1902.)—The author describes some experiments made with the view of determining practically whether the leakage of the charge given to a capillary electrometer, which is afterwards left on open circuit, is accidental, like that of a gold-leaf electroscope, or essential, in the sense that a small current may be necessary to maintain a deflection. No direct experimental investigation of this point appears hitherto to have been made, though Lippmann's mathematical argument is in accordance with the assumption that no current is required to maintain a deflection. This is now confirmed by the author, who describes several experiments showing that a well-insulated and well-made capillary electrometer may maintain its charge, as indicated by the original deflection, for a very long time, in one case as much as 97 per cent. of the original charge (0·025 volt), being retained after 45¼ hours. Even that small leakage was probably largely due to the other parts of the circuit of which the electrometer formed part. This instrument was specially made for other purposes, and is specially rapid and sensitive. The capillary is contained in a glass trough about ½ mm. wide and 25 mm. long, formed by grinding away the front of a thick-walled tube so as to lay open the bore from end to end, and closed in front by a piece of glass. The lower end dips into dilute sulphuric acid, the surface tension of which causes it to fill the trough to its upper end. The acid is in a U-tube with mercury in the bend. The leakage of charge has an external cause and an internal. The weather has a marked influence on it, and the instrument is from its nature difficult to insulate. The internal cause is found in the tendency of the acid, which wets the tube, to insinuate itself between the tube and the mercury, which has no wetting effect. For this reason the author prefers to have a depth of 8 or 10 cm. of mercury in the capillary, and 5 cm. in the U-tube. This internal leakage is least when the electrometer is new. The result of the author's experiments on the minimum quantity of electricity required to produce a visible excursion of the meniscus, is that with his arrangement a quantity equal to $\frac{1}{100}$ electrostatic unit can be measured. The capacity of the author's electrometer, as used in this experiment, is 0·363 microfarad. W. C. H.

ALTERNATING CURRENTS AND MAGNETISM.

103. *Vector Diagrams for Distorted Wave-Shapes.* **J. Teichmüller.** (Phys. Zeitschr. 3. pp. 442–449, July 1, 1902.)—The author considers under what conditions the ordinary vector diagram is applicable to distorted waves. Taking first the case of a simple reactive resistance, he finds that the vector diagram is always applicable. Considering next two such reactive resistances arranged in series with each other, he investigates whether vectorial addition of the p.d. vectors corresponding to the two reactive resistances, correctly gives the total p.d. across them, and finds that in general the result is not correct, and that it only holds for the special case in which the inductances are inversely proportional to the capacities; it further holds if the impedances contain either no capacities or no inductances. The next case considered is that of a number of impedances arranged in parallel, the problem being to determine whether vectorial addition of the various branch currents gives the total current; the method is found to break down except in the special case where the branch circuits have equal power-factors. The author lastly refers briefly to circuits of variable self-inductance (coils containing iron cores), and expresses the opinion that the ordinary graphical methods frequently give untrustworthy results. A. H.

104. *Elimination of Harmonics from Alternator Waves.* **C. F. Guilbert.** (Écl. Électr. 31. pp. 377–380, June 14, 1902.)—The e.m.f. of any alternator can be expressed in the Fourier series: $e = \Sigma A_m \cos(m\omega t - \phi_m)$. Suppose now that the slots in the armature, instead of being parallel to the axis, are inclined to it, that a is the fraction of a half-period, and that one end of a conductor is in advance of the other, then it is shown that the new e.m.f. e' is given by

$$e' = \frac{2}{a\pi m} \Sigma A_m \cos\left(m\frac{2\pi t}{T} - \phi_m + \frac{ma\pi}{2}\right) \sin\frac{ma\pi}{2}$$

Hence if A'_m be the new amplitude of the mth harmonic then—

$$A'_m = A_m \sin\frac{ma\pi}{2} \Big/ \frac{ma\pi}{2}$$

Since the sine of an angle is always less than its circular measure, the amplitude of the mth harmonic is diminished by inclining the conductors to the axis. A'_m vanishes when a is $2/m$, and in this case the pth harmonic is

$$A'_p = A_p \sin\frac{p\pi}{m} \Big/ \frac{\pi p}{m}$$

Hence, as p increases from 1 to m, the ratio of the amplitudes of the harmonics diminishes from a quantity which is nearly equal to unity to zero. A. R.

105. *Graphical Calculation of the Harmonics of an E.M.F. Wave.* **F. Loppé.** (Ecl. Électr. 31. pp. 449–452, June 28, 1902.)—Symmetrical waves of the form $e = \Sigma A_{2n+1} \sin(2n+1)\omega t$ are first considered. If we neglect the harmonics beyond the $(6n+1)$th the value of A_{2n+1} can be found graphically as follows: Divide the base of the positive half of the wave into $(2n+1)$ equal parts and through the points of section draw $2n$ ordinates. The area will then be divided into $(2n+1)$ bands. Let S_1 be the sum of the areas of the odd bands, and S_2 the sum of the area of the even bands, then $A_{2n+1} = \pi(S_1 - S_2)/2a$ where a is the length of the half wave. Other graphical methods are given for both symmetrical and unsymmetrical waves, got on the assumption that all the harmonics beyond the eleventh are zero. A. R.

106. *Hall Effect in Gold for Weak Magnetic Fields.* **W. C. Baker.** (Phil. Mag. 4. pp. 72–84, July, 1902.)—It is known that the Hall effect in certain bismuth-tin alloys depends on the strength of the magnetic field, this change extending even to a reversal of the sign of the effect. Kundt has shown, on the other hand, that for gold and silver the Hall coefficient is constant

for very high fields. The author seeks to discover whether there is any irregularity in the behaviour of gold and silver for very weak fields. Lebret's method is used. The results show that the Hall coefficient for gold is a constant for all fields between 12 and 21,500 units c.g.s. R. S. W.

107. *Theoretical Deduction of Steinmetz's Formula and the Relation Connecting* B *and* H. **J. Döry.** (Zeitschr. Elektrotechn., Wien, 20. pp. 329–332, July 6, 1902.)—The energy loss by hysteresis per cubic cm. per cycle is given by the integral $\frac{1}{4\pi}\int H\,dB$. By regarding B and H as vectors, and introducing the components α, β and γ of H along the three co-ordinate axes, we get the integral in the form—

$$\frac{1}{4\pi}\iiint\left\{\alpha\frac{\partial B}{\partial x}+\beta\frac{\partial B}{\partial y}+\gamma\frac{\partial B}{\partial z}\right\}dx\,dy\,dz.$$

This volume integral may be split up by Green's theorem into a surface and a volume integral, the latter vanishing and the former taking the form—

$$\frac{1}{4\pi F(H)}\iint H\,.\,B\,.\,dS,$$

where F(H) is a function of H. A comparison of this with the original integral leads to the equation—

$$H=f.B^{2F(H)-1},\text{ or }B=\left(\frac{1}{f}.H\right)^{\frac{1}{2F(H)-1}},$$

in which f is a constant of the given material. Using this expression for B, and substituting in the original integral, we get for the hysteresis loss—

$$\frac{f}{8\pi F(H)}.B^{2F(H)}.$$

The special case in which F(H) is equated to a constant = 0·8 leads to Steinmetz's formula. A. H.

108. *Magnetic Rotation in a Variable Electromagnetic Field.* **N. Orlow.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 5b. pp. 233–241, 1902.)—In investigating the mechanical effects of a variable magnetic field, the author happened to observe that a small iron cylinder placed horizontally within a copper-solenoid, would start rotating about its axis when the solenoid was placed beside the pole-pieces of the core of an electromagnet traversed by an alternating current. The same phenomenon was observed when the solenoid was replaced by an horizontal tube of any material. A possible explanation is suggested by the fact that the iron cylinder will tend towards the points of the field, where the force is highest, and some similar cases are recorded. A. G.

109. *The Unifilar Magnetometer.* **P. Schulze.** (Ann. d. Physik, 8. 3. pp. 714–719, June, 1902.)—The author examines the errors arising from initial torsion in the suspending fibre. If torsion exists in the fibre, the needle will not point due N. and S. when in the earth and field alone. On bringing up a magnet to a known distance in the usual way, the torsion will be increased or decreased according to the way the magnet is placed. Thus there will not be symmetry about the normal, and the readings right and left will be

unequal. By taking readings on each side and reducing out, the torsion error can be eliminated entirely. The equations concerned are given and are of a simple form. P. E. S.

110. *Change of Electrical Resistance of Metals in a Magnetic Field.* **J. Patterson.** (Phil. Mag. 3. pp. 643–656, June, 1902.)—The change of resistance of metals when placed in a magnetic field has recently been explained by J. J. Thomson on the corpuscular theory of electric conduction in metals. [See Abstract No. 1672 (1901.)] According to this theory the electric currents in the metals are carried by negatively charged corpuscles moving with a definite velocity under an applied e.m.f. Considering the particles as acting like a perfect gas, they have a mean free path and mean velocity and exert a definite pressure. On the application of a transverse magnetic force the particles move in a cycloid. Consequently the resistance of the conductor is changed owing to the increase of path. If the magnetic force acts in the same direction as the electric force causing the current the corpuscles describe spirals about the lines of magnetic force, and consequently in this case also the resistance is changed. The object of the experiments described in this paper was to observe and measure the change of resistance of non-magnetic metals in a transverse magnetic field. The wires wound non-inductively in carefully insulated spirals were exposed to a transverse magnetic field produced by a large ring magnet of the Du Bois type. The testing arrangement was in the form of a Wheatstone Bridge, a variable resistance R being in circuit with the single Leclanché cell used to give the current, A being the resistance of the test spiral, B, C, D the resistances in the other arms of the bridge, C being in multiple arc with the variable resistance R, the change of resistance $\partial\sigma$ when the magnetic field is put on, the value of the change of resistance due to the magnetic field is given by $\partial\sigma/\sigma$. In the first set of observations copper wire being used, and the magnetic field H being 26,500 and 21,300, the value of $10^{13}\partial\sigma/\sigma H^2$ was found to be 29 and 33 respectively. In further experiments values varying from 23 to 28 were found for the same quantity. These results confirm those obtained by Lenard for copper. Experiments were made with gold platinum, silver, zinc, tin, cadmium, and carbon. The average values of $10^{13}\partial\sigma/\sigma H^2$ in order of magnitude which were obtained are as follows :—

Cd	C	Cu	Zn	Au	Sn	Hg	Ag	Pt
282	44	26	87	37	23	54	26	6

These numbers represent the relative values of $\partial\sigma/\sigma$ for the same magnetic field, and may be taken as giving merely the order of magnitude of the change of resistance in the magnetic field. J. J. Thomson has shown in the paper referred to above that if $n =$ number of corpuscles in unit volume, $e =$ change on a corpuscle of mass m, $u_0 =$ velocity acquired under a unit field, then the conductivity is $1/\sigma = neu_0$. Also $\partial\sigma/\sigma = H^2u_0^2/3$, $\partial\sigma$ being the change of resistance due to the transverse magnetic field H. Using the values found for the change of resistance in the case of platinum u_0 is found to be $3{\cdot}9 \times 10^{-7}$. Also $u_0 = e\lambda/2mc$ where $\lambda =$ the mean free path of the corpuscle, and c the initial velocity, which is about $7{\cdot}6 \times 10^6$ at 27° C. Hence $\lambda = 5{\cdot}9 \times 10^{-7}$ for platinum. Since $neu_0 = 1/\sigma$, $ne = 280$, nearly, in the case of platinum. If N is the number of molecules of hydrogen in 1 c.c. under atmospheric pressure and at 0° C. and e the charge on an ion $Ne = 0{\cdot}4$, and therefore $ne/Ne = 700$, nearly, *i.e.*, the pressure exerted by the corpuscles in the case of platinum is about 700 atmos. The charge on a corpuscle being

6×10^{-10} electrostatic units, $n = 1.4 \times 10^{23}$. Richardson has obtained for n the value $1{\cdot}3 \times 10^{21}$ at temp. 1,542° absolute from the negative radiation of a hot wire. Since t, the time a corpuscle takes to complete its mean free path $= \lambda/C$, this becomes for platinum 8×10^{-14}, and from this $q = cn/\lambda = 1{\cdot}8 \times 10^{35}$. The results for the other metals are given in a table in the paper. The following are the values deduced for the contact-difference of potential in volts for various pairs of metals :—

Cu-Pt	Cu-Au	Cu-Ag	Cu-Cd	Cu-Zn	Cu-Sn	Cu-C
0·0239	0·0117	—0·0015	0·0684	0·0478	0·0546	0·2176

J. J. S.

111. *Mirror Collimation in Declination Magnets.* **K. Haussmann.** (Terrestrial Magnetism, 7. pp. 59–62, June, 1902.)—The author shows by deduction and experiment that the collimation error of a freely oscillating declination needle vanishes on inversion of the needle only when the axis of the two points of suspension passes through the mass centre of the magnetic system. This is easily ensured with thread suspension, but not with needles pivoted on points. A shifting of the point of suspension in the direction of the longitudinal axis of the needle does not matter, and any variation in the vertical intensity during the time of an observation need, therefore, not be taken into consideration ; but any shifting in the direction at right angles will introduce an error which can be allowed for, however. H. B.

112. *Absolute Magnetic Observations at Valencia,* 1899–1901. **J. E. Cullum.** (Roy. Soc., Proc. 70. pp. 246–249, July 8, 1902.)—The observations made by the author from 1887 to 1896 were, in 1899, resumed with new instruments, unifilar and dip circle by Dover, the observatory hut having in 1892 been moved to Cahirciveen, co. Kerry. The declination is determined about 10 a.m., inclination about 11.45 a.m. and 1.25 p.m., and intensity about 11 a.m. and 3 p.m. ; the two middle days of each month are adhered to. H. B.

REFERENCES.

113. *Ohm's Law.* **J. Stark.** (Ann. d. Physik, 7. 4. pp. 932–934, April 8, 1902.) —A correction is made of a conclusion arrived at in a previous paper [see Abstract No. 2184 (1901)], and the author now shows that, for Ohm's law to hold good, the diminution in the moving force along the mean free path of the ions must be small compared with the force at the end of the path. W. E. T.

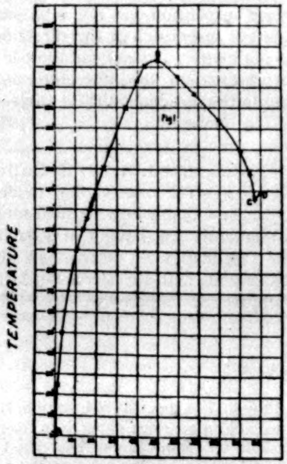
114. *Lag and Lead.* **W. G. Rhodes.** (Elect. Rev. 50. pp. 1002–1003, June 13, 1902.)—A mathematical discussion is given of the meaning of these terms when the p.d. and current waves are not sine curves. A. R.

115. *The Electric Arc Between Iron Terminals in Phototherapy.* **A. Broca** and **A. Chatin.** (Comptes Rendus, 134. pp. 562–564, March 3, 1902.)—Relate some experiences with an arc lamp having poles of iron instead of carbon, and draw attention to the actinic richness of the light emitted. H. L. J.

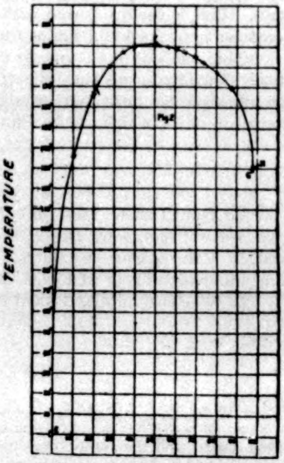
116. *Electrostatic Capacity of the Human Body.* **G. de Metz.** (International Physical Congress at Paris, Report, 4. pp. 119–127, 1900–1901.)—[See Abstract No. 2385 (1901).] H. L. J.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

117. *Behaviour of Succinic and Phthalic Anhydrides towards Water.* **E. van der Stadt.** (Zeitschr. Phys. Chem. 41. pp. 353–369, July 25, 1902.)—Complete melting-point curves are given for the systems succinic anhydride + water and phthalic anhydride + water. The middle of the horizontal scale (50 mols. per cent. of anhydride) represents the melting-point of the acid, which in each case is much above that of the anhydride. Two eutectic points occur on each curve; the eutectic temperature at which ice and acid are in equilibrium with the solution is very little below 0°, owing to the slight solubility of the acids; that at which anhydride and acid are both in equilibrium with the liquid is more clearly marked, especially in the case of succinic anhydride. In each case the curve passes continuously through the maximum, forming a smoothly rounded crest and not a pair of lines intersecting at a sharp angle; this shows that the acid dissociates on melting, and that the fused acid contains free anhydride and free water; the greater roundness of the crest shows that the dissociation when melted of phthalic acid is much greater than that of succinic acid. The two anhydrides are much more soluble, as such, than the acids, but gradually become hydrolysed. On shaking the anhydride with water the solubility therefore at first gradually increases (dissolution of anhydride) and then gradually decreases (hydrolysis of anhydride to acid) to a value identical with that obtained with the acid. At 0° equilibrium is only reached after about 48 hours, at 25° after about 90 minutes, at 50° after about half an hour in the case of succinic anhydride, and similar results were obtained with phthalic anhydride; above 60° the



Succinic Anhydride (mols. per cent.).



Phthalic Anhydride (mols. per cent.).

hydrolysis of the anhydride is very rapid and equilibrium is reached almost instantly. No means are, however, available to determine the proportions in which the anhydride and acid exist together in the liquid state. T. M. L.

118. *General Numerical Connection between Atomic Weights.* **J. H. Vincent.** (Phil. Mag. 4. pp. 103–115, July, 1902.)—"If a list of all the atomic weights in ascending order of magnitude be taken and the order in this list be called n, then the nth atomic weight, from $n = 3$ to $n = 60$, is given by the equation $W = (n + 2)^{1\cdot21}$." Diagrams are given showing graphically the closeness of the atomic weights thus calculated to the values actually observed, certain gaps in the chain being set down as "predicted elements." The mean difference for the elements from H to Sa is about 1·01. The largest individual difference occurs in the case of iodine (+ 3·9), which is also anomalous in the periodic system; other cases of deviation are exceptions to Dulong and Petit's law. The consequence which follows from the assumption that $W = N^q$, where N is a + integer and q a positive number whose actual value approximates to 1·21, is that the list of atomic weights starts abruptly at hydrogen but has no end. The fact that for many years all the elements that have been discovered have atomic weights greater than that of hydrogen and less than that of uranium would point to the conclusion that any law for the connection between the masses of different kinds of atoms should lead to the list of elements being limited at both the beginning and end. S. R.

119. *Hydrogen Compounds of the Metalloids of Group II.* **de Forcrand** and **Fonzes-Diacon.** (Annal. Chim. Phys. 26. pp. 247–271, June, 1902.)—The paper gives a comparative study of the physical properties of water, sulphuretted hydrogen and seleniuretted hydrogen. The bulk of the work has been already published in the Comptes Rendus, vol. 134 [see Abstract Nos. 742 and 743 (1902)]; the data for the hydrate of H_2S are given for the first time. The following table resumes the experiments of the authors and the previously known facts:—

	H_2S	H_2Se	H_2Fe
M.W., Molecular weight ……………	34	81	128
T, Absolute boiling-point……………	211°·4	231°	273°
T_c, Critical temperature ……………	373°·2	410	?
$\frac{T}{T_c}$ ………………………………	0·566	0·564	?
T_c, Critical pressure …………………	92 atmos.	91 atmos.	?
T′, Melting-point ………………………	187°	209°	225°
$\frac{M.W}{D}$, Molecular volume of liquid	39·08	38·20	49·75
D, Density of liquid at B.P. ………	0·87	2·12	2·57
L, Latent heat of vapour……………	4230	4670	?
$\frac{L}{T}$ (Trouton's ratio) …………………	20·01	20·21	?
C, Heat of formation of the hydrate	16340 cal.	16820 cal.	?
t, Temperature at which the hydrate has 760 mm. pressure	273°·25	281°	?
t', Critical temperature of the hydrate	303°	303°	?
S, Solubility in water at …………… 4°	4·04 vols.	3·77 vols.	?
9°·65	3·60 „	3·43 „	?
13°·2	3·35 „	3·31 „	?
22°·5	2·75 „	2·70 „	?

D. H. J.

120. *Velocity of Chemical Reactions.* **R. Wegscheider.** (Zeitschr. Phys. Chem. 41. pp. 62–70, June, 1902.)—In reply to Euler's remarks [see Abstract No. 1390 (1902)] on the criticisms of the author [see Abstract No. 896 (1902)], the latter points out that Euler assumes the equilibrium between the molecules and their ions to be instantaneously attained. But if this is the case, and if also, as Euler supposes, the saponification of esters is an ionic reaction, this latter should be instantaneous, which is not the case. The ionic nature of the reaction of ester-saponification is not in agreement with the observations that: (1) The saponification of sulphonic esters is independent of the hydrogen ions; and (2) That of the carboxylic esters is accelerated by the hydrogen ions, to the concentration of which it is proportional.

T. H. P.

121. *Intramolecular Transposition of Halogen-Acetanilides and its Velocity.* **I. I. Blanksma.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 159–164, June 28, 1902.)—Determinations of the velocity of conversion of acetylchlor-acetanilide into p-chlor-acetanilide show that this is a monomolecular reaction, a true intramolecular transposition taking place, comparable to the transpositions of brom- amides under the influence of alkalis, as studied by Van Dam and Aberson [Recueil des Travaux Chim. 19 (1900)]. Br, Cl, NO_2, NO, and O bound by N, will change places with a H- atom present in the nucleus under the influence of sunlight. The conversion of acetylchlor-acetanilide in alcoholic or acetic acid solution is a consequence of a catalyser (HCl) being formed, the reaction, especially in the sunlight, taking place with increasing velocity. Small quantities of sodium carbonate or acetate may be added in order to prevent the formation of a catalyser. A. G.

122. *Saponification of the Esters of Carboxylic and Sulphonic Acids.* **R. Wegscheider.** (Zeitschr. Phys. Chem. 41. pp. 52–61, June, 1902.)—The saponification of the esters of carboxylic acids is accelerated by the presence of either an acid or a base, so that the reaction is slowest in an almost neutral solution. As regards the saponification of the esters of sulphonic acids, the author's views are embodied in the following conclusions, which are supported by the results obtained by Kastle, Murrill, and Frazer (Amer. Chem. Journ. 19. p. 896): (1) Saponification by water is not accelerated by hydrogen ions as is the case with the carboxylic esters. (2) Acids exert an accelerating influence only when they bring about a secondary reaction having an appreciable velocity. (3) Alkalis have an accelerating action due to their hydroxyl ions, which may be supposed either to act independently of the water or to exert a catalytic action on the latter. If saponification by water is considered in all cases as a reaction of the hydroxyl ions, an accelerating catalytic action must be ascribed to the hydrogen ions, and in the case of the sulphonic esters this action is proportional to the concentration of the hydrogen ions, but in the case of the carboxylic esters it is proportional to the square of the concentration of these ions. T. H. P.

123. *Asymmetric Synthesis.* **E. Fischer** and **M. Slimmer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 28. pp. 597–610, June 5, 1902.)—In order to explain the fact that plants are able to form optically active carbohydrates from carbon dioxide and water, whilst chemical synthesis is always symmetrical, and from inactive material yields only inactive products, E. Fischer has previously put forward the hypothesis that the carbon dioxide is fixed by the complicated optically active substances of the chlorophyll granules, or of the assimilating plant-cell, and that then, under the influence of the once existing asymmetry, the synthetic transformation into sugar also proceeds asymmetrically. If this explanation is correct there is a possibility of causing chemical synthesis to proceed in an asymmetric manner, the starting-point being an optically active substance. Into the molecule of this latter a new asymmetric carbon atom is introduced, and the original active residue then split off; the resulting product should be an asymmetric and optically active compound. In the authors' experiments made to test these views, tetracetylhelicin is converted into its cyanohydrin, the latter being then treated with hydrochloric acid to yield tetracetylgluco-*o*-hydroxymandelamide, which on saponification gives *o*-hydroxymandelic acid; the resulting acid is found to be optically active, but the rotation is too small to base a definite conclusion on. In another experiment the tetracetylhelicin is converted by means of zinc ethyl into tetracetylgluco-*o*-oxyphenylethylcarbinol, which, on hydrolysis, yields *o*-oxyphenylethylcarbinol having a specific rotation of —9·83°. As the dextrose obtained from the hydrolysis of the tetracetylgluco-*o*-oxyphenylethylcarbinol can be used again for the building-up of fresh helicin, there is a theoretical possibility of producing unlimited quantities of the active carbinol from a limited quantity of dextrose, so that the problem of asymmetrical synthesis must be regarded as solved. T. H. P.

124. *Liquid Silicon Hydride.* **H. Moissan** and **S. Smiles.** (Comptes Rendus, 134. pp. 1549–1552, June 30, 1902.)—The authors have further investigated the properties of the new liquid hydride of silicon, which they find to be quite stable when heated to 100°, but to be spontaneously inflammable in presence of air, and to possess strong reducing properties. A vapour-density determination by Gay-Lussac's method gave results agreeing with the formula Si_3H_8. Induction sparks passed through the vapour, decompose it into free silicon and hydrogen. D. H. J.

125. *Amorphous Silicon.* **H. Moissan** and **S. Smiles.** (Comptes Rendus, 134. pp. 1552–1553, June 30, 1902.)—The authors find that the amorphous silicon obtained by passing sparks through the vapour of liquid silicon hydride, possesses marked reducing properties which are not exhibited by the amorphous silicon prepared by Vigouroux; they consider the difference to depend on the state of division of the silicon. A similar phenomenon is found in the case of boron. D. H. J.

126. *Chlorinating Properties of a Mixture of Oxygen and Hydrochloric Acid.* **C. Matignon.** (Comptes Rendus, 134. pp. 1497–1499, June 23, 1902.)—A thermochemical study of the reaction $2HCl + O + M = MCl_2 + H_2O$ (where M is a dyad metal) leads to the conclusion that a mixture of hydrochloric acid and oxygen should be almost as effective a chlorinating agent, at suitable temperatures, as chlorine itself. Copper, lead, silver, and mercury are already known to be attacked at the ordinary temperature; the author has now investigated the action of the above-mentioned mixture on gold, platinum, and tellurium, which are all found to be attacked, with formation of chloride, at temperatures much lower than the temperature of oxidation of hydrochloric acid by oxygen. Tellurium is acted on at the ordinary temperature readily, platinum black much more slowly; sheet platinum and gold are attacked at from 170° to 180° by strong hydrochloric acid in presence of oxygen. D. H. J.

127. *Benzylidene-menthone Isomerides.* **C. Martine.** (Comptes Rendus, 134. pp. 1437–1439, June 16, 1902.)—In continuation of previous work (Comptes Rendus, 133. p. 41) the author has isolated from oily products obtained in the preparation of benzylidene-menthone, two differently crystalline isomers of the latter. The α-modification melts at 51°, is soluble in ether, alcohol, and petroleum, has a rotatory power (α) $= -185° 50'$, and yields an oxime melting at 172°; the β-form, which is obtained in smaller quantity and is probably a stereoisomer, melts at 47°, is more soluble than α in the same solvents, has a rotatory power $= -258°{\cdot}5$, and yields an oxime melting at 153°. The two modifications give a mixture melting at 28°, while the mixed oximes melt at 145°–147°. The values given for the specific rotation appear to confirm Haller's views as to the increase of rotation on introducing a double bond into the menthone nucleus. D. H. J.

128. *Polymerisation and Heat of Formation of Zinc Oxide.* **de Forcrand.** (Comptes Rendus, 134. pp. 1426–1429, June 16, 1902.)—A knowledge of the heat of formation of zinc oxide is important both electrically and metallurgically, but is very imperfectly known; it is recognised, however, that the experimental value is dependent to some extent on the treatment to which the oxide has been subjected. The author found the heat of solution of metallic zinc in dilute sulphuric acid to be 39·31 calories; he then determined, in calories, the heats evolved (27·92, 25·23, 23·91, 23·51) on dissolving in the same acid four specimens of oxide prepared in different ways and heated respectively to 125°, 300°–350°, 350°–400°, and the temperature of combustion of zinc in oxygen. Hence the heats of formation of the specimens of oxide are 80·29, 82·98, 84·30, 84·70 calories respectively, so that if we assume that there is polymerisation on heating, the polymerisation is exothermic and disengages 4·41 calories. D. H. J.

129. *Extended Theory of Dilute Solutions.* **H. Jahn.** (Zeitschr. Phys. Chem. 41. pp. 257–301, July 25, 1902.)—In order to account for the fact that Ostwald's dilution law does not hold for "strong" electrolytes, the author has suggested that in concentrated solutions the ions are more mobile than in dilute solution, and that very large errors may therefore be introduced into the law of Arrhenius, according to which the coefficient of ionisation is given in the formula $\alpha = \lambda/\lambda_\infty$. Much lower values were given when the coefficients of ionisation were calculated from the e.m.f. of concentration cell, but even these were not in accordance with Ostwald's law. An extended theory of solutions is therefore brought forward, in which allowance is made for the mutual influence of (1) the free ions and the undissociated molecules and (2) the free ions amongst themselves, as well as for the influence of the solvent upon these. Modified formulæ are given for: (1) Ostwald's law; (2) van't Hoff's laws for the depression of the freezing-point, elevation of the boiling-point and lowering of the vapour pressure; (3) concentration cells; (4) influence of electrolytes on the solubility of non-electrolytes; and (5) chemical equilibrium and reaction velocity. In support of the correctness of these new formulæ a few experimental results are advanced, dealing with the freezing-point of solutions of KCl and NaCl and the e.m.f. of concentration cells containing these salts. [See also Abstract No. 1888 (1900).] T. M. L.

130. *Heat of Dilution of Solutions of Sodium Sulphate.* **A. Colson.** (Comptes Rendus, 134. pp. 1496–1497, June 23, 1902.)—The author has already shown [see Abstract No. 519 (1902)] that the heat of dilution

becomes nil at particular temperatures, for certain solutions in which the state of aggregation of the dissolved body is independent of the degree of dilution. Sodium sulphate has now been selected by the author as a type of substance which varies in composition with the concentration, and it is shown experimentally that solutions of sodium sulphate show no constant dead-point at which the heat of dilution vanishes. D. H. J.

131. *Solubility of Carbon Monoxide in Binary Organic Mixtures.* **F. W. Skirrow.** (Zeitschr. Phys. Chem. 41. pp. 139–160, July 8, 1902.)—The author has investigated the solubility of carbon monoxide in solutions of various organic substances in benzene, toluene, acetone, acetic acid, and finds that the dissolving power is in general an additive property. A number of deviations from this rule were, however, met with, and these were found to be connected with deviations from the additive law in the case of surface tensions of mixtures, in such a way that where the surface tension shows a minimum the solubility is a maximum. These are the first cases in which maxima of solubility of gases have been found. The vapour pressure of some of the solutions at 25° was also determined. A. F.

132. *Artificial Dichroism of Liquid Crystals.* **O. Lehmann.** (Ann. d. Physik, 8. 4. pp. 908–923, July, 1902.)—Dichroism is seen particularly well in the case of methoxycinnammic acid which melts at 170·6° to a crystalline liquid, passing at 181·5° to an isotropic liquid. The liquid crystals are of themselves quite colourless, but are capable of dissolving safranine, alkannin, and alizarine, and the mixtures exhibit strong dichroism. Usually this was seen by the crystals occupying a particular position appearing colourless in two quadrants and coloured in the other two quadrants of the field of view of the microscope. The paper also contains a reply to Tammann's suggestion that liquid crystals are merely emulsions of two liquids which solidify to a clear solid on cooling. [See also Abstract No. 1876 (1900).] T. M. L.

133. *Oceanic Salt Deposits, XXVII. Artificial Preparation of Pinnoite.* **J. H. van't Hoff** and **G. Bruni.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 35. pp. 805–807, July 10, 1902.)—Whilst the chlorides appear in the salt-beds in a normal form as carnallite, $KMgCl_3$, $6H_2O$, the sulphates appear in dehydrated forms as kieserite $MgSO_4$, H_2O and anhydrite, $CaSO_4$, and the borates similarly appear in forms containing unusually small proportions of water. Boracite, $6MgO$, $8B_2O_3$, $MgCl_2$ has already been prepared artificially, but only by fusion of the constituents or in presence of water at 270°—conditions entirely different from those under which it must have been formed in the salt-beds. A number of attempts were made to prepare the mineral pinnoite, MgO, B_2O_3, $3H_2O$; (1) the action of boric acid on magnesium hydroxide or basic carbonate gave the salt MgO, $3B_2O_3$, $7H_2O$, by gradual evaporation of the solution at 60–70°; (2) the double decomposition of magnesium nitrate and borax gives two well-known salts, closely related to pinnoite, viz., MgO, B_2O_3, $8H_2O$, and MgO, B_2O_3, $4H_2O$; (3) double decomposition of magnesium chloride with borax gave the first of these salts and also a salt with a slightly smaller proportion of base $3MgO$, $4B_2O_3$, $11H_2O$; (4) finally pinnoite was obtained by a decomposition similar to (3) but with an excess of magnesium chloride as a dehydrating agent; after five days on the water-bath the formation of pinnoite from borax and magnesium chloride was complete. Pinnoite was also obtained from boracite by heating on a water-bath with a concentrated solution of magnesium chloride. T. M. L.

134. *Liquefaction of Gaseous Mixtures.* **J. P. Kuenen.** (Zeitschr. Phys. Chem. 41. pp. 43–51, June, 1902.)—The author criticises certain results arrived at in Caubet's paper [see Abstract No. 1932 (1902)] on the liquefaction of gaseous mixtures. In particular he points out that a proposition of Duhem's, in relation to the real and theoretical isothermals in the critical domain, again put forward by Caubet, had been shown by Hartman to be wrong, and not merely based on insufficient proof, and he establishes this on general grounds by showing that at the first and second condensation points the theoretical isothermal is steeper than the real one. He claims that the results obtained with methyl chloride and sulphur dioxide would mean that a real isothermal had been found for which $dp/dv > 0$! He suggests that the obtaining of a maximum and a minimum in the vapour pressure may be due to the formation of a complex molecule, but remarks peculiarities in the motion of the maximum and minimum. In conclusion, he draws attention to the interesting application of the *p-t* figures to the determination of the volume and composition of coexisting phases. W. E. T.

135. *Change of Partial Density of a Solvent with the Concentration of the Solution.* **N. Schiller.** (Ann. d. Physik, 8. 3. pp. 588–599, June, 1902.)—The results obtained in the previous papers on the thermodynamics of saturated and unsaturated solutions [see Abstract Nos. 1735 (1901) and 354 (1902)] are further extended. The paper is of a mathematical nature, general formulæ being deduced. Besides the solution of a substance dissolved in a solvent, the case of two liquids dissolving in one another is considered, both when the liquids mix in all proportions, and when for a certain concentration they form saturated solutions. W. E. T.

136. *Microstructure of Hardened Steel.* **J. O. Arnold** and **A. M'William.** (Iron and Steel Inst., Journ. pp. 1–16, May, 1902.)—The authors dissent from the views of Roberts-Austen, Roozeboom, and others as to the constituents of hardened steel. Of these, they recognise only three, "hardenite," $Fe_{24}C$, ferrite, Fe, and cementite, Fe_3C. They classify steel as unsaturated or supersaturated, according as it contains less or more than 0·89 per cent. C., the proportion required for the formula $Fe_{24}C$. Martensite, the name used by Roberts-Austen, Roozeboom, and others for the whole series of hard "mixed crystals" of isomorphous iron and carbon, of which "hardenite" is one member, is here regarded as applying to a particular structure appearing in hardened steel and not a particular constituent. The "alleged constituents," sorbite, troostite, and austenite are severely criticised, as also is Roozeboom's application of the phase rule, which does not appeal to "practical scientific men who have grave responsibilities connected with steel metallurgy." T. M. L.

137. *Sulphur Contents of Slags and other Metallurgical Products.* **Y. v. Jornsdorff.** (Iron and Steel Inst., Journ. pp. 1–28, May, 1902.)—Sulphur in iron alloys exists chiefly as MnS and FeS, and in slags as CaS, MnS, FeS, ZnS, and MgS. The solubility of these sulphides in the slag is only small, but within the limits of solubility the proportion of sulphur in the metal and in the slag is determined by the usual laws for the distribution of a solute between two imperfectly miscible solvents. Thus the ratio of sulphur in the metal to that in the slag will always tend to the same value for a given composition of metal and slag at a given temperature, but will be slightly influenced by changes of temperature and very largely by changing the composition of metal or slag. The ratio of distribution, sulphur per cent. in slag / sulphur per cent. in metal, has been investigated (1) in the blast furnace, (2) in the open hearth process of making steel, and (3) in the basic Bessemer process, and is found to increase (1) with the basicity of the slag, (2) with the proportion of CaO and MnO in the slag, (3) with the proportion of C and Mn in the iron, but to decrease with the percentage of phosphorus in the iron. Thus in the basic Bessemer process it is only when the phosphorus has been nearly all removed from the iron that the sulphur begins to be taken up by the lining. Again, whilst it is easy to desulphurise iron rich in carbon and manganese, this can only be done in the case of iron poor in carbon and manganese, either by starting with a very pure iron or by repeated removal of the old slag and formation of a new slag. T. M. L.

138. *Action of Silver Salts on Ammonium Persulphate.* **H. Marshall** and **J. K. H. Inglis.** (Roy. Soc. Edinburgh, Proc. 24. pp. 88–93, May, 1902.)—A study of the velocity of the reaction, and the influence of other salts, in the decomposition of ammonium persulphate in the presence of a soluble silver salt, when nitric and sulphuric acids are formed [see Abstract No. 900 (1902)]. The rate of change approximates to a monomolecular reaction, showing that it takes place in several stages, one of which being much slower than the others, determines the velocity. At 50° the velocity is about eight times greater than at 25°. The course of the change was watched by determining the acidity in a position (after removing the silver by NaCl) every 24 hours. The table of results shows that neutral salts are somewhat retarding, but the end point is the same as with persulphate alone. Acids at first cause acceleration, but the end point is not the same, indicating the simultaneous occurrence of some other action which results in the production of less acid. Assuming the existence of perargentic ions ("diargention") the interaction of persulphates and silver salts might be $2Ag^{\cdot} + S_2O_8'' \Longrightarrow 2Ag^{\cdot\cdot} + 2\,SO_4''$. In the absence of oxidisable substances hydrolysis takes place, with separation of perargentic hydroxide, oxide or basic salt. In presence of ammonium ions, however, it would become—

$$8Ag^{\cdot\cdot} + NH_4^{\cdot} + 3H_2O \Longrightarrow 8Ag^{\cdot} + 10H^{\cdot} + NO'.$$

S. R.

139. *Catalysis of Hydrazine.* **S. Tanatar.** (Zeitschr. Phys. Chem. 41. pp. 37–42, June, 1902.)—Pursuing the idea that in reactions where there are bye-products, a catalyser may favour the formation of one product at the expense of another, the author has studied the decomposition of hydrazine. Hydrazine, as sulphate, decomposes in hot aqueous solution in presence of platinum black, in accordance with the equation, $3N_2H_4 = 4NH_3 + N2$; while free hydrazine under similar conditions decomposes, according to the equation—$2N_2H_4 = 2NH_3 + N_2 + H_2$. In presence of excess of sodium hydrate, free hydrazine decomposes catalytically thus—$3N_2H_4 = 2NH_3 + 2N_2 + 3H_2$. [See also Abstract No. 1911 (1902).] D. H. J.

140. *Fluorides and Oxyfluorides of Sulphur.* **H. Moissan** and **P. Lebeau.** (Annal. Chim. Phys. 26. pp. 145–178, June, 1902.)—The authors have prepared and investigated three new gaseous sulphur and phosphorus compounds, viz., sulphur hexafluoride, SF_6, sulphuryl fluoride, SO_2F_2, and thionyl fluoride, SOF_2. The properties of these bodies differ markedly from those of the corresponding chlorine compounds and emphasise the

exceptional position of fluorine amongst the halogens. The hexafluoride is an extremely stable substance, so that, *e.g.*, it is only partly decomposed by several hours' sparking from an induction coil and it is not attacked by copper oxide at a red heat. D. H. J.

141. *Properties of Mixtures of the Lower Alcohols with Benzene and with Benzene and Water.* **S. Young** and **E. C. Fortey.** (Chem. Soc., Journ. 81. and 82. pp. 739–752, June, 1902.)—The aliphatic alcohols are, on the one hand, paraffins, and, on the other hand, alcohols; in a former paper the alcoholic characteristics were considered; in the present paper experiments are described which emphasise the paraffin nature of the aliphatic alcohols. The paraffin character is found to be more marked as we ascend the series. The authors have distilled mixtures of the alcohols with benzene and also with benzene and water. Benzene was chosen as a substitute for a paraffin on account of the ease with which it may be obtained pure; it acts in these experiments in much the same way as, say, hexane. Methyl, ethyl, isopropyl, n-propyl, isobutyl, and tertiary butyl alcohols all form binary mixtures of constant boiling-point when distilled with benzene. Moreover, the boiling-points of these constant mixtures, and the molecular percentages of benzene in them, follow the same order as the boiling-points of the pure alcohols. Ethyl, isopropyl, n-propyl, and tertiary butyl alcohols form ternary mixtures of constant boiling-point with benzene and water, and the behaviour in general of the ternary mixtures examined is closely related to the boiling-point of the alcohol. D. H. J.

142. *Distillation of Two Non-miscible Liquids.* **E. Charabot** and **J. Rocherolles.** (Comptes Rendus, 135. pp. 175–177, July 21, 1902.)—Naumann's well-known formula for the relative weights P and P′ obtained on distillation of two non-miscible liquids is $P/P' = MP/M'P'$, where M and M′ are the molecular weights of the liquids and P and P′ the separate vapour pressures at the temperature of ebullition. Using water for one of the liquids (so that $M' = 18$), the author has examined both by calculation and experiment the effect of rise of boiling-point on the value of P/P'. He finds that liquids may be divided into two classes—(*a*) those for which the ratio P/P' is less than unity, as limonene, linalol, geraniol, citronellol, methyl heptenone; (*b*) those for which the ratio is greater than unity, as pinene, benzene, isopentane, n-hexane, carbon tetrachoride. In the former case (for temperatures below the critical point) the value of the ratio P/P' rises, in the latter case it falls, with increase of temperature. D. H. J.

143. *The Formation of Mixed Crystals by Sublimation.* **G. Bruni** and **M. Padoa.** (Accad. Lincei, Atti, 11. pp. 565–569, June 15, 1902.)—All the mixed crystals so far examined have been obtained from fusion or from solution. The author has studied mixed crystals formed by sublimation. The substances employed were first fused together and placed in a bulb tube which was exhausted of air. The bulb was then heated to a temperature lower than the melting-point of the mixed substances, so as to form a sublimate. The latter was examined under the microscope to test its homogeneity and analysed. Each pair of substances was chosen so that one substance was coloured and the other colourless, as stilbene and azobenzene, mercuric iodide and bromide, mercuric iodide and chloride. It was found in each case that the sublimate was homogeneous, even though in the case of the mercuric iodide and bromide experiments the percentage of iodide varied from 20 to 80. The

following table summarises the results of the experiments with iodide and bromide of mercury :—

Expt.	Percentage of Mercuric Iodide.		Coefficient of Partition = $\frac{C_1}{C_0}$
	In Original Mixture (C_0).	In Sublimate (C_1).	
I.	19·92	18·81	0·92
II.	48·81	36·52	0·84
III.	60·06	50·44	0·84
IV.	80·02	71·74	0·90

D. H. J.

144. *Rate of Interaction of Arsenious Acid and Iodine.* **J. R. Roebuck.** (Journ. Phys. Chem. 6. pp. 365–398, June, 1902.)—The oxidation of arsenious to arsenic acid by iodine and the reverse reduction of arsenic to arsenious acid by hydrogen iodide in accordance with the equation—

$$H_3AsO_4 + I_2 + H_2O \rightleftharpoons H_3AsO_4 + 2HI$$

were studied by three methods, viz.—(1) Determination of rate of direct action; (2) determination of rate of reversed action; (3) determination of equilibrium between these actions. The equilibrium constant in (3) should be equal to the quotient of the velocity constants in (1) and (2); actually these qualities were found to be of the same order of magnitude, viz., $1·5 \times 10^5$, for the directly observed equilibrium constant, and $8·6 \times 10^5$ for the quotient of the velocity constants; the numerical difference is perhaps accounted for by the somewhat different conditions necessary in the three series of measurements. T. M. L.

145. *Alloys of Magnesium and Cadmium.* **O. Boudouard.** (Comptes Rendus, 134. pp. 1431–1434, June 16, 1902.)—The author has prepared alloys of magnesium and cadmium; they are fairly soft and difficult to polish for microscopic examination, brittle if continually hammered, permanent in dry air, but easily oxidised by moist air. The curve obtained by plotting the percentages of magnesium as ordinates against the fusibilities as abscissæ presents three maxima (at 500°, 565°, and 650°) and two minima (at 400° and 560°). The last maximum represents a combination less fusible than either of the constituents. The three maxima correspond to the formulæ $CdMg$, $CdMg_4$, $CdMg_{30}$; the last compound could not be isolated; the other two were obtained as crystalline powders fairly pure for analysis by treating buttons of the alloys with 1 per cent. ammonium chloride solution. D. H. J.

146. *Alloys of Copper and Manganese.* **E. A. Lewis.** (Soc. Chem. Ind., Journ. 21. pp. 842–844; Discussion, p. 844, June 30, 1902.)—The author has examined some physical properties of alloys prepared from pure copper and 97 per cent. manganese obtained by the Goldschmidt process. The specific gravities and freezing-points are:—

% of Mn	0	1	5	10	55	20	25	30	40	50
Sp. Gr.		8·935	8·757	8·425	8·102	8·284	7·782	7·746	7·324	7·332
Fr. Pt. °C.	1065	1080	1060	1000	935	915	890	885	880	—

The specific gravities of alloys containing more than 50 per cent. of Mn are of no value, as the alloys are not compact. Alloys with 50 per cent. or more Mn show two solidifying points, of which one is due to the separation of the eutectic alloy (46·61 per cent. of Mn). The hardness of the alloy increases from 1 per cent. upwards to 50 per cent., when the hardness is greater than that of steel. Tensile test-pieces which had been rolled and annealed gave the following results :—

Per cent. Mn.	Annealed Sheet.	
	Tensile Strength, Tons per sq. in.	Elongation per cent. on 4 in.
0·0 (sheet copper)	13·83	49
1·0	15·73	41
4·8	18·91	43
7·55	20·00	30
15·80	24·46	28
21·24	28·33	23·5
26·24	29·7	12
32·14	26·56	3

The author gives diagrams to illustrate the microstructure of etched surfaces of the alloys. One per cent. of Mn does not affect the microstructure, but with 5 per cent. of Mn the large copper crystals begin to disappear, and with 10 per cent. the mass consists of small crystals of copper surrounded by the eutectic alloy. At about 50 per cent. the eutectic mixture becomes the chief micro-constituent. The author is unaware of any English railway company which uses the copper-manganese alloys ; the 5 per cent. alloy is used on several foreign railways for locomotive stay-bolts ; the 1 per cent. alloy is employed for locomotive and other tubes which have to resist corrosion. D. H. J.

147. *Colloids.* **W. R. Whitney.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 853–860, June–July, 1902.)—Colloidal "solutions," such as those of platinum and gold, of oxides and sulphides, sulphur and selenium and silicic acid, are regarded as being conditioned by the presence of electrostatic charges on the particles of the colloid, which in aqueous solutions are usually positive, the water (with the higher dielectric constant) being usually negative. The sign of the charge can be determined from the direction in which the particles tend to move when charged electrodes are introduced into the liquid, and the repulsion of the similar charges on the different particles would prevent coagulation. Such solutions or suspensions are precipitated by electrolytes and it is suggested that the charge on the particles are then neutralised by (*e.g.*) the kathions of the electrolyte, of which the metal would be to some extent carried down by precipitated colloid as hydroxide, whilst the solution would retain the anion as free acid. The fact that natural animal and vegetable products are never ash-free is regarded as due to their precipitation in this way by electrolytes from colloidal solutions. T. M. L.

148. *Possibility of a Colloidal State of Gases.* **C. Barus.** (Amer. Journ. Sci. 13. pp. 400–402, May, 1902.)—When nuclei derived from the same source and under like conditions are suspended in different media, the appearance and behaviour of the coronas, which become visible on successive condensation by the exhaustion method, are different according as the suspending medium is a vapour from a strongly ionising liquid (*e.g.*, water, methyl alcohol, ethyl alcohol), or one from a non-ionising liquid (*e.g.*, gasoline,

benzine, benzol, &c.). Considering this different behaviour the author concludes that the nuclei must be very small in the first case and relatively large in the second. The nucleus consists of clusters of many molecules, the clusters having a given average size for a given vapour. As the nuclei may be obtained without putting anything material into the receiver by passing X-rays through it, and such nuclei behave in the same way as those otherwise produced, we must consider that the receiver contains within itself the material out of which the nucleus is made, and the question is, which of the gases involved (air or vapour) is thus made colloidal? The enormous difference of the size of the nuclei in the two kinds of solvents, electrolytic and non-electrolytic, seems to be against the air, and in favour of the vapour being selected. The difference of size then corresponds to the electrochemical differences of the liquids. From the similarity of the nuclei to that of particles of clay suspended in the corresponding liquids, the author thinks it not unreasonable to look on this behaviour as indicating a colloidal state of the gas in question. The nucleus is condensed and held together by the electron, and in turn condenses the water globules, seen as coronas on exhaustion. W. C. H.

149. *Properties of Nuclei.* **C. Barus.** (Science, 15. pp. 912-914, June 6, 1902.)—From an extended series of experiments made by shaking dilute solutions, using a great variety of solutes, the author finds that the number of nuclei produced under identical conditions of agitation varies with the violence of the agitation and the bulk of solution used, and particularly with the concentration of the solution and its chemical nature. Also the apparent rate of decay of nuclei with lapse of time diminishes with the strength of the solution. The inference is therefore tenable that the nuclei shaken out of stronger solutions are larger. The author gives the following theory for the production of these nuclei: A particle of pure water produced by shaking will either vanish by complete evaporation or will grow larger and vanish by subsidence. But if the evaporating globule is a solution, the increment of vapour pressure at the surface of increasing convexity will gradually be compensated by the decrement of vapour pressure due to increasing concentration of the solution. There must therefore be a critical diameter at which the increased vapour pressure due to surface tension just balances the decreased vapour pressure due to concentration. This is the stable diameter of the nucleus. The author deals with the question whether this simple mechanism of producing exceedingly minute stable nuclei by mere shaking is not sufficient to account in general for nuclei in the presence of saturated vapour. W. C. H.

150. *On the Triple-Point.* **P. Saurel.** (Journ. Phys. Chem. 6. pp. 399-409, June, 1902.)—This is a purely mathematical paper, in which the author gives two methods for completely classifying all the various possible kinds of triple-points. As the author himself admits, a complete classification of this sort (by a different method) has been already given by Roozeboom in his book on Heterogeneous Equilibria. F. G. D.

151. *On a Theorem of Tammann.* **P. Saurel.** (Journ. Phys. Chem. 6. pp. 410-416, June, 1902.)—In the present paper an extension to the case of the multiple-point of an n-component system is given of a theorem due to Tammann which was recently proved by the author. The theorem is as follows: "Construct in the volume-entropy plane a triangle whose vertices

have for co-ordinates the specific volume and specific entropy of each of the three phases of an invariant one-component system, and from a point within the triangle drop perpendiculars on the three sides. If the temperature-pressure plane be so placed that the temperature axis is parallel to the entropy axis, and the pressure axis parallel to the negative direction of the volume axis, then the perpendiculars just drawn are respectively parallel to the directions at the triple-point of the stable portions of the three univariant curves." F. G. D.

152. *Theory of the Bessemer Process.* **F. Fischer.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1006–1008, July 5, 1902.)—Of the combustible constituents of iron, that which yields the greatest amount of heat per atom of oxygen is silicon, the product being either silica or a silicate; manganese follows next, then phosphorus, iron, and carbon. This is, therefore, the order in which oxidation might be expected to take place, but the volatility of the products of combustion would also be of importance, and would favour the combustion of the carbon. In addition to the primary oxidation secondary changes, probably reversible and governed by the law of mass action, may also take place in the converter, *e.g.*, reduction of CO and CO_2 by Si and Mn, but not by Fe, though SiO_2 may be partially reduced by the metallic iron.

T. M. L.

153. *Depression of the Freezing-point of Aqueous Electrolytes.* **J. G. MacGregor.** (Elektrochem. Zeitschr. 9. pp. 51–55, June; and pp. 74–79, July, 1902.)—Experiments were carried out in order to determine whether, as required by the theory of electrolytic dissociation, a linear relationship existed between the molecular depression of the freezing-point of an aqueous electrolyte and the coefficient of ionisation as determined by conductivity measurements. The linear law was found to hold good in the case of KCl up to about 0·3N, NaCl to 0·1N, HCl to 0·1N, K_2SO_4 to 0·1N, Na_2SO_4 to 0·3N, and H_2SO_4 to 0·6N. Similar, but less concordant, results were obtained with solutions containing mixtures of the chlorides and sulphates. From the observations made the molecular depressions for the different ions, and (though less accurately) for the different undissociated salts can be calculated. The values deduced were :—

	For the salts.	For the ions.
KCl	2·032	1·841
NaCl	2·071	1·871
HCl	1·564 1·433	1·832 1·850
K_2SO_4	2·194	1·853
Na_2SO_4	2·196	1·875
H_2SO_4	1·762	1·831

The values for the ions are very concordant, and the mean value 1·850 agrees exactly with that deduced theoretically from the latent heat of fusion, and with that observed in non-electrolytic solutions. The values for the undissociated salts are grouped into pairs, the acids giving lower values than the neutral salts; as, however, the values had to be deduced from solutions of only moderate dilution, it is probable that the differences are due to variations from the linear law which occur in all solutions which are much stronger than 0·1N; the mean value, 1·895, does not differ seriously from the mean value for the ions.

The relationship between freezing-point and conductivity appears, therefore, to hold good within 1 per cent. in solutions not stronger than 0·1N.
T. M. L.

154. *Recrystallisation of Platinum.* **W. Rosenhain.** (Roy. Soc., Proc. 70. pp. 252–254, July 8, 1902.)—The well-known alteration in the appearance and structure of platinum (as attested by its increased brittleness) when exposed to flame is now shown to be due to recrystallisation at high temperatures similar to that already described by Ewing and Rosenhain [see Abstract No. 664 (1901)], and not to the action of carbon or acetylene as previously supposed. The alteration in appearance is, however, due to the etching action of the flame-gases, and in this action the temporary formation of a carbide may play a part. W. G. M.

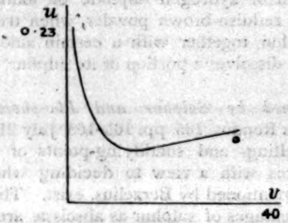
155. *Relations of Sulphur and Iodine and the Iodides of Sulphur.* **R. W. E. MacIvor.** (Chem. News, 86. pp. 5–7, July 4, 1902.)—The blackish-grey material obtained by heating a mixture of iodine and sulphur in atomic proportions is, according to the author, not a chemical compound of the composition S_2I_2, but must be regarded as a solution or as a kind of alloy. The same is the case with the substance obtained by Guthrie by the action of sulphur monochloride on ethyl iodide. These bodies give up all their iodine when treated with alcohol or potassium iodide solution, and when acted on by potassium hydroxide, crystalline sulphur is left behind; further, a solution in carbon disulphide, when evaporated, deposits crystals of increasing sulphur content. It appears, however, that a compound of the formula S_3I_2 can be obtained by the action of hydrogen sulphide on iodine trichloride. This compound, which is a reddish-brown powder, when treated with potassium hydroxide, yields sulphur together with a certain amount of thiosulphate; carbon disulphide only dissolves a portion of its sulphur. T. H. P.

156. *Mixtures Formed by Sulphur and Phosphorus below* 100°. **R. Boulouch.** (Comptes Rendus, 135. pp. 165–168, July 21, 1902.)—The author has examined the melting- and solidifying-points of various mixtures of sulphur and phosphorus with a view to deciding whether definite compounds, such as those mentioned by Berzelius, exist. The curve of solidification, in which the percentages of sulphur as abscissæ are plotted against the solidifying temperatures as ordinates, consists of two lines which cut sharply at a eutectic point representing 9·8 and 0·228 per cent. The author concludes that no definite compound of phosphorus and sulphur exists below 100°, but that mixed crystals isomorphous with, and rich in, octahedral sulphur or others isomorphous with, and rich in, phosphorus may be separated by crystallisation from fusion. D. H. J.

157. *Molecular State of Potassium Iodide in Phenol.* **E. H. Riesenfeld.** (Zeitschr. Phys. Chem. 41. pp. 346–352, July 25, 1902.)—The distribution-ratio of KI between the two phases of a phenol-water mixture is found not to vary very greatly with concentration. As the KI is known to be highly dissociated in the aqueous phase, it is concluded that such is also the case in the phenolic phase (which contains 30 per cent. water). This conclusion is supported by conductivity measurements, which show that with varying concentration the equivalent conductivity remains approximately constant. The equivalent conductivity is, however, low, and this is attributed to smaller ionic mobilities in the phenolic phase. Direct diffusion experiments, based on Nernst's theory

of the diffusion of electrolytes, lead to the ratio 1 : 3·7 for the ionic mobilities in water and the phenolic phase, whereas the ratio 1 : 5 was obtained from the conductivity measurements. In anhydrous phenol the conductivity of KI is very low and the equivalent conductivity increases rapidly with dilution. The molecular weight of KI in anhydrous phenol (Beckmann freezing-point method) is found to be normal. On adding water to a solution of KI in anhydrous phenol, the equivalent conductivity increases almost proportionately to the molecular concentration of the solution with respect to water. This increase is considered by the author to be due to an increase of dissociation of the KI, which he regards as probably caused by combination with the water. F. G. D.

158. *Electric Conductivity of Solutions in Ethyl-Iodide.* **W. Plotnikoff.** (Jurn. Russk. Fisik. Chimičesk. Obščestva, 34. 5a. pp. 466–472, 1902.)—Solutions of $AlBr_3$ in C_2H_5Br are found to exhibit rather low conductivities; within the concentrations tested, the conductivity ranges from 0·065 to 0·23, whereas in aqueous solutions of neutral salts, this magnitude averages about 100. The march of the variation of the electric conductivity, as the concentration is altered, differs greatly from the behaviour shown in the case of aqueous and of most non-aqueous solutions, in that the conductivity corresponding to a normal solution of $AlBr_3$ is nearly three times that of decinormal solutions; this magnitude thus greatly diminishes, as the concentration decreases, whereas the molecular conductivity, as a rule, is known to augment with the dilution, tending in some cases towards a value ($\mu\infty$). In more dilute solutions, however, the conductivity of $AlBr_3$ is found to increase, as shown in the accompanying curve—



The conductivities of the complex compound $AlBr_3 . C_2H_5Br . Br_2 . CS_2$ behave in a way closely resembling that of $Al . Br_3$. These experiments clearly show a relation between the conductivity and the formation of complex compounds. The increase in the conductivity of the aluminium bromide with increase of concentration may equally be explained by the formation of complexes, the more so as $AlBr_3$ gives, with C_2H_5Br, a crystalline compound. The experiments may, however, also be accounted for on the theory of electrolytic dissociation. The simple ions Al possess but a low electric affinity, whereas together with the formation of complex ions, the electro-affinity and, accordingly, the number of free ions may undergo a considerable increase. On increasing the concentration of $AlBr_3$, the formation of complex ions may occur according to the following equation :—

$$n\,AlBr_3 + n\,C_2H_5Br = [Al.\,(n-1)\,AlBr_3 .\,m\,C_2H_5Br] + 3\,[Br].$$

For $n = 4$, the molecular weight may be normal, according to the formula $AlBr_3$. On diluting the solution, the complex ions are decomposed, the simple ions formed uniting with Br ions to form neutral particles of $AlBr_3$, thus explaining the observed minimum conductivity. A. G.

159. *Sedimentation.* **J. Joly.** (Roy. Dublin Soc., Trans. 7. pp. 391–402, May, 1902.)—A finely powdered solid, when allowed to settle in an aqueous electrolyte of sufficient concentration, exhibits a well-defined boundary, the particles apparently settling at a rate that is independent of their size and of the concentration of the electrolyte, below a certain concentration (about five times greater for monad positive ions than for diad) a distinct surface fails, the coarser particles settling first and the finer particles being held in suspension for a long time, so that a very complete separation of the sediment results; at intermediate concentrations a boundary can still be traced, and this falls at the standard rate, but the liquid above the boundary, instead of being clear, is more or less turbid, owing to the presence of fine particles falling at a slower rate. A suspension precipitated at a concentration so low as to be near the point of failure will, if reshaken, not again exhibit a distinct surface, even when covered with fresh electrolyte of equal strength, but may do so with an electrolyte of considerably greater concentration; the electrolyte, however, behaves in the normal way when shaken with a fresh lot of powder. The fresh powder is electronegative towards distilled water; the used powder is approximately neutral towards its salt solution. The view is advanced that the low specific inductive capacity of the powder as compared with the water leads to the aggregation of the negatively charged particles, independently of their magnitude, a process which occurs only slowly when the particles, now nearly neutral, are again disturbed. [See also Abstract No. 147 (1903).] T. M. L.

160. *Conductivity and Dielectric Constants of Solvents and Solutions up to and above the Critical Temperature.* **P. Eversheim.** (Ann. d. Physik, 8. 8. pp. 539–567, June, 1902. Abstract of Dissertation, Bonn, 1902.)—The dielectric constants and conductivities were measured simultaneously, when possible, by a Wheatstone's bridge method, the liquid being enclosed in a sealed tube provided with an arrangement by which it could be turned upside down in order to secure efficient mixing; the tube was heated in an oil-bath and the electrical resistance and capacity were measured between concentric platinum cylinders fixed inside the tube. Measurements of the conductivity of solutions of potassium bromide, and iodide in sulphur dioxide confirmed Hagenbach's observation that the conductivity falls with very greatly increased rapidity over a few degrees below the critical temperature and then becomes almost constant in the gaseous state. A temperature of maximum conductivity was observed in a solution of rubidium iodide at about 0°C. In a precisely similar manner the dielectric constant of the solvent was found to fall steadily according to a linear law from 13·8 at 20° to 4 at 150°, then to drop very rapidly from 150° to the critical temperature at 154°, becoming almost constant at 1·9 above the critical temperature. (The temperatures given are *uncorrected* for part of the thermometer outside the oil-bath.) Similar observations were made in the case of ether, the dielectric constant falling steadily from 4 at 20° to 1·9 at 187°, then falling very rapidly to 1·4 at the critical temperature at 191°, and remaining constant at 1·4 at higher temperatures. The conductivity of a 8·9 per cent. ethereal solution of hydrogen chloride was also determined between —69° and 196°. It was found to exhibit a maximum of conductivity at about —22°, the conductivity falling to 5/6 of the maximum value at —69° and at 8°; in the neighbourhood of the critical temperature the specific resistance was found to become very great, amounting to six million ohms at 184° and becoming immeasurably great at the critical temperature, 190·8°. The dielectric constant of ethyl chloride was found to vary in a similar manner, falling from 6·8 at 150° to 6·0 at 175°, then more rapidly to 4·4 at the critical temperature at 185°, and remaining constant at higher temperatures. The conductivity of solutions of mercuric chloride in ethyl chloride was found to reach a maximum at about 80°, whilst at a temperature just below the critical the specific resistance increased to over two million ohms. In order to test the accuracy of the Mosotti-Clausius formula $(D-1)/d(D+2)=\text{const.}$ (where $D=$ dielectric constant and $d=$ density) the density of ether was determined and was found to fall from 0·720 at 15° to 0·246 at the critical temperature, whilst that of ethyl chloride fell from 0·904 at 15° to 0·466 at the critical temperature. It was then found that the "constant" in the above formula increased with rising temperature in the case of sulphur dioxide and ethyl chloride, but decreased greatly in the case of ether. [See also Abstract No. 1741 (1901).]

T. M. L.

161. *E.M.F. of Ozone.* **A. Brand.** (Deutsch. Phys. Gesell., Verh. 4. 11. pp. 246–250, June 13, 1902.)—One gram molecule of ozone sets 29,600 calories free by its decomposition, and it might be expected that this energy of deozonisation could be converted into the energy of an electric current. The author constructed a gas-cell similar to the Grove gas-cell, except that O_2 — Pt and O_3 — Pt were the electrodes. It was found that a current of considerable strength flowed from the oxygen electrode through the electrolyte to the ozone electrode. The e.m.f. of the cell was determined by the compensation method of Wilsmore's arrangement [see Abstract No. 906 (1901)]. The following gives some of the results for the e.m.f. of the ozone electrode :—

17° Ozone volume per cent. ...	0·69	1·25	3·44	5·45
E.M.F.	0·836	0·867	0·922	0·916
0° Ozone volume per cent. ...	0·75	1·00	4·46	5·15
E.M.F.	0·883	0·907	0·949	0·950

The values obtained however were found to be dependent to some extent on the state of the surface of the platinum; it was noticed regularly that the values of e.m.f. were the larger for an O_3 — Pt phase, the smaller the values for the same plate as an O_2 — Pb electrode.

D. H. J.

162. *Concentration-cells with Non-miscible Solvents.* **E. H. Riesenfeld.** (Ann. d. Physik, 8. 3. pp. 616–624, June, 1902.)—The combinations used were of the type KCl aq. (conc.) | KCl in phenol | KCl aq. (dil.), the electrodes being reversible mercury (calomel, &c.) electrodes. The e.m.f. was first determined with the two aqueous solutions directly in contact, and then with the phenolic solution interposed. The difference of e.m.f., depending on the potential differences at the surfaces of the non-miscible layers, can be calculated if the transport values for the ions in phenol solutions be known, and conversely the transport values can be calculated from the observed e.m.f. When this is done the transport values are found to vary in a similar manner when determined in the two ways, but the values determined from the concentration-cells are considerably lower than those determined directly, thus :—

	KI	KBr	KCl	LiCl
Transport value measured directly	0·809	0·804	0·808	0·771
,, ,, from concentration-cells	0·646	0·648	0·645	0·574

T. M. L.

163. *Galvanic Cell and Phase-rule.* **W. Reinders.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 115–126, June, 1902.)—Nernst and Bancroft, when endeavouring to base the theory of galvanic cells upon the phase-rule, both failed to take into account the proposition : " Phase A being in equilibrium with phases B and C, those latter phases will also be in equilibrium with one another."

The author considers, from the point of view of the phase-rule, a cell made up of a combination of two metallic electrodes, each surrounded by an electrolyte containing the cations of those metals and connected either directly or by means of a third electrolyte. Now, between these electrolytes and the corresponding metal, there may exist equilibrium and a well-defined constant p.d., whereas a continual diffusion will take place between the electrolytes, altering the composition and p.d., a real equilibrium being obtained only in so far as both electrodes are capable of being in equilibrium with the same electrolyte, the e.m.f. thus becoming $=0$. An apparent equilibrium may however be obtained by reducing the diffusion to a minimum, this being the case of the so-called constant elements. Before considering the equilibrium of the cell, the author investigates the equilibrium in the two metal-electrolyte systems separately, two cases being considered, as the electrode may first be made up of one metal only, the surrounding electrolyte containing cations only of this metal, or else the two metals M_1 and M_2, the electrolyte containing cations of both of them. In the latter case, a distinction has to be made according as these two metals do not react upon each other, or form a definite combination, or else a homogeneous liquid or solid solution. A theoretical study of the constant cells is next given, the conditions rendering the system invariant being considered in each case. A. G.

164. *Dissociation Constants of Oxalacetic Acid and its Phenylhydrazone.* **H. O. Jones** and **O. W. Richardson.** (Chem. Soc., Journ. 81. and 82. pp. 1158–1160, Aug., 1902.)—The authors have ascertained the dissociation constants of the two bodies from observations of the conductivities of the solutions at 25° : for oxalacetic acid, $K = 1{\cdot}33$; for the hydrazone, $K = 0{\cdot}11$.

D. H. J.

165. *Ionisation of Solutions by Light and Röntgen Rays.* **J. A. Cunningham.** (Cambridge Phil. Soc., Proc. 11. pp. 431–433, Aug., 1902.)—An attempt was made to find whether ions were produced in solution by the action of light and of Röntgen rays. The source of light employed was an alternating arc between carbon terminals in the cores of which thick iron wires were inserted. By means of two quartz lenses the light from this arc was made to converge upon the film of solution placed in a suitably shaped electrolytic cell. Difficulty was found in keeping the temperature constant before and after turning on the light. It was found that the increase of conductivity of the solutions dealt with, due to illumination by an arc rich in ultra-violet rays, never amounted to as much as 1 per cent. of the conductivity of the given solution prepared and kept in the dark. It was greatest for solutions of ammoniacal silver chloride, uranyl nitrate, and colloidal silver, but the actual figures obtained could not be relied upon. With Röntgen rays there was a distinct small effect which was greatest for strong solutions of Hoffman's violet, in which 8·7 per cent. increased conductivity was detected. J. J. S.

166. *Thermodynamics and Dissociation Theory of Binary Electrolytes.* **M. Planck.** (Zeitschr. Phys. Chem. 41. pp. 212–223, July 8, 1902.)—For any two solutions, differing very slightly in concentration, a relationship can be deduced by pure thermodynamics between the osmotic pressure, the freezing-point or boiling-point, the vapour pressure and the e.m.f. developed in a concentration cell by the two solutions. This relationship, expressed in the form of an equation, is independent of all molecular theories and contains only one constant which cannot be determined by direct measurement; this constant is related to the thermodynamic potential of the solution, the others are experimental constants such as the latent heat and Hittorf's transportation value for the electrolyte. To this fundamental relationship the dissociation theory adds certain assumptions, connecting the unknown constant with the constant of the gas equation, and the so-called degree of dissociation of the solution; Ostwald's dilution law is also a deduction from the theory. These additional laws hold good, however, only for dilute solutions, *i.e.*, for solutions so dilute that the volume and energy of the solution are *linear* functions of the concentration. The steadiness of the constant in Ostwald's equation may be used as an indication that these conditions are fulfilled. The four methods referred to above give a means of determining the ionisation *statically*, the motion of the ions is not involved, and there is no time factor. The conductivity and reaction-velocity may also be used for determining ionisation, but these are regarded as *dynamic* methods, since a time factor is introduced and the rate of motion of the ions is probably involved in each case. The question therefore arises as to what dilution must be reached before the ionic friction becomes sensibly constant, and the author considers that this point has not been sufficiently tested, and that the dynamic methods of measuring ionisation are therefore inferior to the static methods. T. M. L.

167. *Electrolytic Conduction without Electrodes.* **C. Hering.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 819–825, June–July, 1902.)—The author discusses the question whether the action taking place in the electrolyte depends on the actions which occur at the electrodes. Several methods have been proposed for solving the problem [see Abstract No. 1508 (1899)]. Van Heuser (Elektrochem. Zeitsch., June, 1900) describes a method in which the electrolyte flows in a very rapid stream through a magnetic field, and suggests that electrolysis might be thus performed in cases where the electrodes are much attacked. The author describes an apparatus by which a steady current might be produced in a circuit composed entirely of electrodes. This consists of a unipolar dynamo in which the current is induced in a column of electrolyte. The magnet contains two circular concentric tanks connected together; these are filled with the electrolyte and the magnet made to revolve. The circuit is completed by a stationary U-tube filled with the electrolyte, of which one limb is cut by the magnetic field. A current will be produced, and may be indicated by dividing the circuit into compartments by porous partitions; copper sulphate solution is placed in one of the compartments, and sulphuric acid in those adjacent to it. The blue copper sulphate will move into one or other of these, depending on the direction of the current. The author has not actually constructed the apparatus.

W. C. B.

168. *Electrocapillary Properties of Bases and of their Salts.* **Gouy.** (Comptes Rendus, 134. pp. 1305–1307, June 2, 1902.)—The author previously stated that the salts of the same acid give, in equivalent solutions, electrocapillary curves which differ very little whatever be the base of the salts; he has since studied the salts of organic bases, and finds that the above generali-

sation does not apply to them, but should be restricted to bases that are little or, as the mineral bases, not at all active by themselves. Organic bases are active, and the more so the greater the complexity; their salts, too, are active, and give wider curves than the non-organic salts. From the present point of view, two classes of organic bases have to be distinguished: (1) Strong bases such as hydrates of tetramethylammonium; these bases are almost as strong bases and as good conductors as potash or soda. The free base and the salts give curves which differ but little, so that the effect is here to be attributed to the free kations obtained by almost complete dissociation. (2) Weak bases such as amylamine, for which the curve obtained with the base has its maximum much more depressed than in the case of the salts; the effect produced by the free base is due in large part to the non-dissociated molecules; the effect produced by the salts must be attributed to the active kations. [See also Abstract No. 714 (1902).] D. H. J.

169. *Influence of Voltage on Formation of Ozone.* **A. Chassy.** (Comptes Rendus, 134. pp. 1298–1300, June 2, 1902.)—On account of a concentration limit, the effect of a constant potential difference is not proportional to the time. To compare the effects of different voltages the author finds the time required to produce the same concentration. There are two phases in the action of the field. At the lower voltages the author can find no simple law, but as the potential difference between the plates of the ozoniser is gradually increased, a simple law is finally reached, viz.: "The power of production of ozone is proportional to the square of the efficacious potential difference which exists between the armatures." R. S. W.

170. *Apparatus for Electroanalytical Purposes.* **F. Hanaman.** (Zeitschr. Elektrochem. 8. pp. 398–401, June 19, 1902. From the Analytischen Laboratorium der k. k. Technischen Hochschule in Wien.)—The ordinary unsystematised placing of the different appliances (resistances, ammeters, &c.) necessary for electroanalytical work requires much space and makes the locating of an interruption difficult on account of the multiplicity of improvised wire connections. The author describes a compact, permanent arrangement of most of the apparatus, in a box; the different instruments are put in connection, at will, by switches and the like. The apparatus is to be obtained from Herr Pickard, Mechaniker, Wien X, Waldgasse 40.

D. H. J.

171. *Electrolytic Separation of Mercury and Copper.* **C. R. Spare** and **E. F. Smith.** (Chem. News, 85. pp. 280–282, June 13, 1902. From the Journal of the American Chemical Society, 23. No. 8.)—The author's reply to various objections raised against the separation of mercury and copper by electrolysis. They find that the separation is complete, no traces of copper being found in the mercury deposited. The time required can be much diminished by heating the electrolyte to 65° C. The paper contains a table of experimental results. W. C. B.

172. *Electrolytic Determination of Bismuth.* **O. Brunck.** (Ber. Deut. Chem. Gesell. 35. pp. 1871–1873, May 24, 1902.)—Bismuth is precipitated quantitatively and in a compact form on a wire-gauze electrode, provided that the current-density does not exceed 0·5 amperes per sq. dm. in solutions containing 0·1 g. Bi per 100 c.c., or 0·1 ampere per sq. dm. in solutions containing 0·05 g. per 100 c.c. The best method is to dissolve the metal or

compound in enough nitric acid to prevent the separation of basic salts on diluting to 100 c.c., to electrolyse at a pressure of only 2 volts from a battery of accumulators in parallel, and to start the electrolysis at 70–80° C., allowing the solution to cool spontaneously, so as to reduce the current automatically as the solution becomes more dilute. In order to prevent resolution of the metal the current is continued for a short time after transferring the electrodes to the solution employed for washing. The method does not suffice to separate bismuth and lead, as the lead peroxide that separates at the anode always contains bismuth. The maximum error recorded in fourteen experiments is 0·0005 g. T. M. L.

173. *Electrolytic Reduction of Potassium Chlorate.* **G. H. Burrows.** (Journ. Phys. Chem. 6. pp. 417–426, June, 1902.)—The author finds that in the electrolysis of potassium chlorate with copper electrodes, the reduction efficiency of the current can reach a maximum of 200 per cent. The solution of $KClO_3$, used in most of the experiments, was of a concentration of 50 grams of salt per litre. The electrodes were of sheet copper, and one of them, usually the anode, was rotated, contact being made by means of a mercury cup on the stem of the rotating electrode. The efficiency was found to increase with increasing current-density at the anode, and reached a maximum value of 200 per cent. when this was very high; the efficiency fell as the temperature was lowered, being 142 per cent. at 37° C.–39° C. With constant current the reduction decreased as the time increased; this effect seeming to be due to the production of alkali, for on addition of more alkali the reduction almost ceased. The author shows that the efficiency of 200 per cent. might be due to one of the following causes: (*a*) Spontaneous decomposition of the $KClO_3$ with simultaneous formation of $KClO_4$; (*b*) change in the valency of the copper dissolved; (*c*) reduction at the anode as well as at the kathode, either by the metal or through the intervention of hydrogen. Experiments are described which show that the only tenable hypothesis is that which involves direct reduction by the metal of the anode. These results are in harmony with those of Binz [see Abstract No. 154 (1899)], who observed that in the reduction to indigo-white, of indigo suspended in caustic soda solution, using a zinc anode, the metal was the direct agent of reduction. From these and other experiments, Binz and Hagenbach [see Abstract No 266 (1900)] conclude that many reductions attributed to nascent hydrogen are in reality due to direct action of a metal. The author points out that the simultaneous reduction at anode and kathode may be applicable in other reductions. W. C. B.

174. *Etching on Metals by Means of Electric Current.* **A. H. Sirks.** (Konink. Akad. Wetensch. Amsterdam, Versl. 11. pp. 217–224, June 28, 1902.)—The author describes a new method of separating crystals out of any cast metals and alloys, in order to ascertain the properties and composition of those substances. A polished surface of the material to be tested is etched upon by using it as the anode of an electric current, a piece of copper being the kathode. The current was supplied by an accumulator battery of an e.m.f. of 4 volts, and water containing 6 drops of 10 per cent. sulphuric acid to every 100 c.cm. served as electrolyte. The author summarises the advantages of this method as follows: (1) Results may be obtained in cases where the usual polishing and etching method fails; (2) the preparations obtained will show much more detailed drawings and a stronger relief than usual etching preparates; (3) polishing need not be so careful as with the

usual method ; (4) Crystals or crystal fragments, as separated from different alloys by this method, showed on being analysed remarkable differences with respect to the average percentage of the alloys. A. G.

175. *Electrolysis of Molten Salts.* **R. Lorenz.** (Zeitschr. Anorg. Chem. 31. 4. pp. 385–391, July, 1902.)—In reply to recent criticisms, the author states that, though he had not, as H. Danneel maintains, enunciated the opinion that molten salts may be electrolysed at any voltage, a similar behaviour is by no means in disagreement with our knowledge of what are termed "residual currents." The instance of Helfenstein's investigations [see Abstract No. 1718 (1900)] is quoted, this chemist having obtained an excess of efficiency over Faraday's law, in electrolysing molten silver chloride at 1,050°, when, in the anode space, in addition to chlorine, some silver was deposited. The interpretation of Reinder's work on the hypothesis of so-called impoverishment phenomena, as suggested by a contributor to the "Elektrochemisches Jahrbuch," is next shown to be improbable, as all attempts to show the existence of such phenomena have failed. The author finally states that he is quite aware of the precautions necessary in applying Nernst's formulæ to molten electrolytes. The investigation of these phenomena, he says, is gradually advancing, but the matter is difficult. [See also Abstracts Nos. 425 and 2225 (1901) and 746 (1902).] A. G.

176. *Disintegration of Kathodes owing to the Formation of Alloys of the Kathode Material with Alkali Metals.* **F. Haber** and **M. Sack.** (Zeitschr. Elektrochem. 8. pp. 245–255, May 1, 1902. From the Chemisch-technischen Inst. der technischen Hochschule, Karlsruhe.)—An explanation by Bredig and Haber [see Abstract No. 261 (1900)] that the phenomenon was due to the formation of alkali-metal alloys with the kathode-metal, which alloys were then attacked and disintegrated by the action of water, is now confirmed. Since alloys rich in sodium are vigorously attacked by solutions at ordinary temperatures, the measurements were made under refrigeration, generally with the aid of a paste of ether and carbon dioxide. The electrolyte used was a solution of lithium chloride in methylic alcohol. *Lead-Sodium.*—A series of lead-sodium alloys was made, fragments broken off, and measurements taken of the p.d. when opposed to Hg/HgO in LiCl. Alloys containing between 4·5 and 8 per cent. of Na vary much as to their p.d., whilst those with more Na are increasingly readily attacked by water, until an alloy is reached forming blue or olive-green needles, which is at once entirely disintegrated on immersion. *Tin-Sodium.*—The behaviour of tin is analagous to that of lead. *Platinum-Sodium.*—A platinum plate was kept for some minutes in melted sodium at a red heat. On cooling and immersing in alcohol, after the sodium had been removed by the resulting reaction, several decigrams of platinum powder were found to have separated, the plate being greyish-black in appearance. *Sodium-Amalgams.*—Amalgams with less than 2 per cent. of Na show almost the same p.d. as pure Hg when opposed to a standard electrode, but with above 2·3 per cent. of Na, the p.d. is much higher and nearly constant. O. J. S.

177. *Formation of Precipitates, Soluble with Difficulty by Electrolysis with Soluble Anodes.* **M. le Blanc** and **E. Bindschedler.** (Zeitschr. Elektrochem. 8. pp. 255–264, May 1, 1902. Communicated by the Physikalisch-Chemischen Inst. der Technischen Hochschule, Karlsruhe.)—This article

details the results of the experimental examination by the authors of Luckow's process for the electrolytic production of lead chromate and white lead. An accumulator cell was used, with two lead kathodes and one lead anode, and a current of 2 amperes, giving a current density of 0·0059 ampere per sq. cm. Beginning with a 1½ per cent. solution of a mixture of 80 per cent. $NaClO_3$ and 20 per cent. K_2CrO_4, the current being 2·1 volts, a fine covering of $PbCrO_4$ was formed on the anode, but without adhering to it. This covering fell in a continuous stream to the bottom of the vessel, whilst hydrogen was evolved at the kathode, no reduction of chromate being noticeable. The p.d. at 2·1–2·2 volts remained constant, and after two hours the yield of lead chromate was found to be from 98·5 to 99 per cent. of the theoretical. Experiments were tried using solutions of different degrees of concentration, with the addition of such ingredients as $NaNO_3$, $NaC_2H_3O_2$, NaCl and sodium butyrate, but with indifferent results. O. J. S.

178. *Temperature and Efficiency of Electric Furnaces.* **G. Gin.** (Électricien, 23. pp. 363–364, June 7, 1902.)]—By considering, in the case of an arc furnace, the gaseous cylinder between the electrodes as an ordinary conductor, the author obtains, both for arc and resistance furnaces, the following approximate expression for the efficiency, in which M is the mass of substance treated in unit time, C_s and C_l are the mean specific heats in the solid and liquid state respectively, C_f is the latent heat of fusion, C_r the heat absorbed in the diurnal reactions, T_f and T_r are the temperatures of fusion and reaction respectively, and K is a constant depending on the construction of the furnace—

$$\frac{W\{C_f + C_r + C_l(T_r - T_f)\}}{W\{C_f + C_r + C_l(T_r - T_f)\} + KT_r}.$$

G. W. de T.

179. *Reactions during the Formation of Calcium Carbide.* **G. Gin.** (Zeitschr. Elektrochem. 8. p. 397, June 19, 1902.)—The author draws attention to the fact that, in the formation of calcium carbide, free oxygen appears at the upper electrode (at which the temperature is hottest) while gaseous metallic calcium is given off from the cooler parts of the furnace. Assuming that at the highest temperature of the furnace there is complete dissociation of carbon monoxide, the author suggests the equation $2CaO + 4C = 2CaC_2 + O_2$ to explain the evolution of oxygen, and the equations—

$$\left.\begin{array}{l} mCaC_2 + nCaO = (m+n)\,Ca + C_{2m}O_n \\ CaC_2 + 2CaO = 3Ca + 3CO \end{array}\right\}$$

to explain the evolution of calcium at the boundary region between oxide and carbide. D. H. J.

180. *Lead Anodes in Phosphoric Acid.* **F. Fischer.** (Zeitschr. Elektrochem. 8. p. 398, June 19, 1902.)—A golden-yellow solution of perplumbic phosphate was obtained by passing a current of 0·05 ampere per sq. dcm. between lead electrodes immersed in a phosphoric acid solution of 1·02 specific gravity. The yellow colour of the solution was well marked after electrolysing for 24 hours. D. H. J.

181. *An Oxycarbide of Cerium.* **J. Sterba.** (Comptes Rendus, 134. pp. 1056–1059, May 5, 1902.)—The author has obtained a well-defined oxy-

carbide of cerium, of the composition $CeC_2 . 2CeO_2$, by the partial reduction of cerium oxide by lampblack in Moissan's tube electric furnace; a current of 600 amperes at 120 volts was used. The product was partly freed from impurities mechanically, and treated with cold water to decompose carbide; after levigation, to remove graphite and cerium hydroxide, it was washed with alcohol and ether, and thus obtained as transparent brown crystals of specific gravity, 4·8 at 17°. The oxycarbide is relatively stable in water and air, and gives by decomposition with acids, unsaturated hydrocarbons. D. H. J.

182. *Tantalum obtained in the Electric Furnace.* **H. Moissan.** (Chem. News, 85. pp. 279–280, June 13, 1902. From the Bull. Soc. Chim. series 3. vol. 27, No. 10.)—Tantalic acid, which has hitherto been regarded as irreducible by carbon and infusible, was prepared from niobite, and after mixing with about 10 per cent. more than the theoretical quantity of sugar-charcoal, was made into cylinders. The cylinders were subjected to a preliminary heating in a Perrot furnace, and then packed in a graphite crucible and heated in an electric furnace supplied with a current of 800 amperes at 60 volts; the heating was continued for ten minutes, so as to fuse the tantalum. The tantalum prepared in this way may contain not more than 0·5 per cent. of carbon, and is a brilliant crystalline mass of sp. gr. 12·79, hard enough to scratch quartz, and infusible in the oxyhydrogen blowpipe. Tantalum, like niobium, possesses strong reducing powers, and so far resembles the metalloids rather than the metals. D. H. J.

183. *Electrochemical Equivalent of Silver.* **A. Leduc.** (Comptes Rendus, 135. pp. 237–240, July 28, 1902.)—The deposit of silver is normal, to 0·01 per cent., in neutral concentrated solutions of $AgNO_3$ saturated with oxide of silver, under anodic current-densities less than 0·002: if the anodic current density exceed this limit, or if the solution be weaker or if it be warm, then is HNO_3 formed at the anode, the presence of which causes a loss of silver at the kathode. Acidity of the bath increases this loss at the kathode. [See also Abstracts Nos. 889 (1900) and 934 (1901).] A. D.

184. *Electrolytic Precipitation and Separation of Silver.* **W. H. Fulweiler** and **E. F. Smith.** (Chem. News, 86. pp. 57–58, Aug. 1, 1902. From the Journal of the American Chemical Society, 23. No. 8.)—The authors have studied the electrolytic deposition of silver from cyanide solutions, and also its separation from solutions containing also copper; copper and cadmium; and copper, cadmium, zinc, and nickel. A current density of about 0·02 amperes and a potential difference of 1·2 volts was employed. The temperatures of the solutions varied from about 60 to 80°. In all cases a perfect separation of silver could be obtained. A. F.

185. *The Electrolytic Method applied to Uranium.* **L. G. Kollock** and **E. F. Smith.** (Chem. News, 86. pp. 65–66, Aug. 8, 1902. From the Journal of the American Chemical Society, 23. No. 8.)—The authors have ascertained the conditions under which uranium can be quantitatively determined by the electrolytic method in solutions of the acetate, sulphate, and nitrate. Table I. gives details of the experiments with uranium acetate; similar satisfactory results were obtained with the nitrate and sulphate. Table II. gives par-

ticulars of the separation of uranium from barium, calcium, magnesium, and zinc.

TABLE I.

ELECTROLYSIS OF URANIUM ACETATE.

	Ur_3O_8 present.	29 per cent. acetic acid.	Dilution.	Current.	Voltage.	Temperature.	Time.	Ur_3O_8 found.
	Grm.	C.c.	C.c.			°C.	Hours.	Grm.
1.	0·0986	0·2	125	$N.D._{107}$ = 0·29 A	16·25	70	5	0·0988
2.	0·0986	0·2	125	$N.D._{107}$ = 0·3 A	12·2	70	5	0·0989
3.	0·1972	0·2	125	$N.D._{107}$ = 0·55 A	13·5	70	4	0·1968
4.	0·1972	0·2	125	$N.D._{107}$ = 0·3 A	10·75	70	6	0·1970
5.	0·1972	0·2	125	$N.D._{107}$ = 0·135 A	5·5	70	5	0·1966
6.	0.2952	0·2	125	$N.D._{107}$ = 0·16 A	4·5	75	5	0·2946
7.	0·2952	0·1	125	$N.D._{107}$ = 0·1 A	4·5	70	7	0·2948
8.	0·2298	0·1	125	$N.D._{107}$ = 0·09 A	4·25	70	6	0·2297
9.	0·2298	0·2	125	$N.D._{107}$ = 0·07 A	4·25	70	5½	0·2299
10.	0·2298	0·1	125	$N.D._{107}$ = 0·05 A	4·0	65	5	0·2299

TABLE II.

SEPARATION OF URANIUM FROM BARIUM, CALCIUM, MAGNESIUM, AND ZINC.

A.—*From Barium* (*Acetates*).

	Ur_3O_8 present.	Barium present.	29 per cent. free acetic acid.	Dilution.	Temperature.	Current.	Voltage.	Time.	Ur_3O_8 found.
	Grm.	Grm.	C.c.	C.c.	°C.			Hours.	Grm.
1.	0·1116	0·11	0·5	125	70	$N.D._{107}$ = 0·02 A	2	5½	0·1119
2.	0·1116	0·11	0·5	125	65	$N.D._{107}$ = 0·04 A	8	5½	0·1117
3.	0·1116	0·11	0·2	125	70	$N.D._{107}$ = 0·1 A	4·5	4	0·1117

B.—*From Calcium* (*Acetates*).

		Calcium present.							
1.	0·1116	0·1	0·2	125	70	$N.D._{107}$ = 0·025 A	2·25	6½	0·1113
2.	0·1116	0·1	0·2	125	70	$N.D._{107}$ = 0·04 A	2·5	5½	0·1114
3.	0·1116	0·1	0·2	125	70	$N.D._{107}$ = 0·05 A	2·25	4¼	0·1113
4.	0·1116	0·1	0·2	125	70	$N.D._{107}$ = 0·025 A	2·0	4¾	0·1115

C.—*From Magnesium* (*Acetates*).

		Magnesium present.							
1.	0·1116	0·1	0·1	125	70	$N.D._{107}$ = 0·026 A	2·25	6	0·1115
2.	0·1102	0·1	0·1	125	70	$N.D._{107}$ = 0·05 A	2·25	5¼	0·1104
3.	0·1120	0·1	0·1	125	75	$N.D._{107}$ = 0·15 A	4·0	4	0·1119

D.—*From Zinc* (*Acetates*).

		Zinc present.							
1.	0·1120	0·1	0·1	125	70	$N.D._{107}$ = 0·021 A	2·25	6	0·1120
2.	0·1102	0·2	0·2	125	70	$N.D._{107}$ = 0·017 A	2·25	6	0·1099
3.	0·1102	0·1	0·1	125	70	$N.D._{107}$ = 0·02 A	2·2	6	0·1100
4.	0·1102	0·1	0·2	125	75	$N.D._{107}$ = 0·025 A	4·4	4½	0·1103
5.	0·1102	0·15	0·2	125	75	$N.D._{107}$ = 0·01 A	2·2	6	0·1105
6.	0·1102	0·2	0·2	125	75	$N.D._{107}$ = 0·02 A	2·25	6	0·1099

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